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ERRATA.

Page	Line	For	Read
10,	(Note) 5th,	"in the Naval,"	in Naval.
26,	Heading of 9th col.,	"Mean,"	Near.
30,	10th,	"979,"	977.
35,	1st of Note,	"of this gun,"	with this gun.
55,	11th,	"12" "	21"
56,	7th,	"03" "	1' 03"
93,	17th,	"with the fuze,"	with regard to the fuze.
96,	1st,	"segmented,"	segmental.
104,	31st,	"Thourenin,"	Thouvenin.
138,	25th,	"0.72,"	0.75.
168,	14th,	"percussion,"	percussive.
173,	4th,	"Origin and anomalies,"	Origin of anomalies.
181,	24th,	"probably,"	properly.
217,	27th,		(omit) "and."
222,	24th,	"1475,"	1500.
230,	20th,	"effected,"	affected.
232,	16th,	"does,"	do.
241,	3d,	"51lbs,"	51lb.
250,	5th,	"o"	0°
"	16th,	"as,"	for.
261,	21st,	"short 30-Pdr.,"	short 30-Pdrs.
266,	25th,	"66,"	46.
281,	23d,	"ship *Minerva*,"	practice ship *Minerva*.
287,	16th,	"by order,"	by the order.
311,	11th,	"without,"	with.
319,	27th,	"The 10-in. shell-gun,"	A 10-in. shell-gun.
326,	1st,	"Petropaulvoski,"	Petropaulski.
327,	3d,	"miles,"	mile.
345,	25th,	"affect,"	affected.
370,	2d of Note,		(omit) "though bulkier."
374,	21st,	"1855,"	1854.
374,	16th,	"Kershon,"	Kherson.
393,	6th,	"action,"	actions.
407,	10th,	"indistinctive,"	indistinct.
410,	8th,	"inefficient,"	insufficient.

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SHELLS

AND

SHELL-GUNS.

BY

J. A. DAHLGREN,

COMMANDER IN CHARGE OF EXPERIMENTAL ORDNANCE
DEPARTMENT, NAVY YARD, WASHINGTON.

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TO

CAPTAIN A. H. FOOTE, U. S. N.

COMMANDING U. S. SHIP PORTSMOUTH,

THIS WORK

IS INSCRIBED BY THE WRITER IN MEMORY OF

A Friendship

THAT BEGAN AS MESSMATES,

AND HAS CONTINUED

THROUGH THE VICISSITUDES

OF

MANY YEARS.

"IF THE NAVY BE INDEED THE "RIGHT ARM "OF DEFENCE," AS IS SO OFTEN REPEATED, IT MAY, "WITH GREAT FORCE, BE ADDED, THAT HER GUNS "AND ORDNANCE APPLIANCES ARE THE MAIN "SINEWS AND ARTERIES, THE NEGLECT OF WHICH "WOULD SOON RENDER IT FEEBLE AND PALSIED."

Annual Report of Hon. J. C. Dobbin,
Secretary of the Navy.

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PREFATORY.

SOME of the conclusions reached in the course of the following remarks, are so much at variance with long cherished views, that it would be unreasonable to suppose they will pass without comment and rigid scrutiny—which I am persuaded they will be found to endure when tried by the standard of principles to which all must yield assent.

The results cited in support are few; but they represent a large number from practice, executed with scrupulous care, and, in the course of an experience extending over some ten years with cannon of every denomination, from a boat 12-pdr. to pivot-cannon of seven tons, I have seen nothing to shake my faith in the soundness of the particular opinions referred to.

I shall abstain from entering upon any discussion of the general theory of Naval Ordnance, because my peculiar notions in this respect are now passing a practical ordeal which, if fully and properly conducted, will be more conclusive than the most elaborate argument.

Indeed, whatever I might urge in their behalf must necessarily be of far less force than the following

emphatic sanction from the highest Naval authority of our country.

"The cautious and sound judgment of the late "Commodore Morris approved the new ordnance."

"After investigation, I unhesitatingly sustained the "recommendation to fit out the new frigates with their "present formidable battery."

Apart, however, from all considerations of a personal nature, the Annual Report of the Hon. Secretary of the Navy embodies so much of general interest in regard to ordnance, which is treated in a masterly manner, that I should hardly be excused by the Navy for quoting no more than might be gratifying to myself. Wherefore the entire passages allotted to this subject will be given here.

REPORT OF THE SECRETARY OF THE NAVY.

NAVY DEPARTMENT, Dec. 1, 1856.

SIR:—I have the honor to submit the annual report from this department, showing the duties performed by the several squadrons, the present condition of the service, with recommendations of further legislation.

* * * * * * * * * * * *

* * * * * * * * * * * *

ORDNANCE AND GUNNERY—PRACTICE-SHIP.

I know of no part of the service more entitled to the liberal patronage of the government than ordnance and practical gunnery. If the navy be, indeed, the "right arm of defence," as is so often repeated, it may, with great force, be added that her guns and ordnance appliances are the main sinews and arteries, the neglect of which would soon render it feeble and palsied. Our national ship may attract admiration for the strength and beauty of her model, and the graceful ease with which she glides

on the water; her men may be patterns of discipline, and her officers the bravest and best; yet all this will avail nought in the dread hour of battle, if either her guns refuse to be faithful messengers, or are managed by those who are untaught in practical gunnery. Americans are adepts in the use of the rifle and the musket from their boyhood, and when thrown into the field, no matter how suddenly, they are skilful, and their aim is as fatal as that of the trained soldier. Of course, the case is very different in regard to the management of a cannon, weighing thousands of pounds, upon a disturbed sea. In the British service they have their gunnery practice-ship, where officers and men are trained to the use of cannon as thoroughly and as regularly as the soldier is drilled in the army. We have thus far relied upon practising at sea, and selecting from the crew for captains of guns those who may, from experience, be found best fitted. It is amazing, indeed, that, notwithstanding the importance of disseminating through the service a thorough knowledge of gunnery, no system for that purpose has ever been adopted. It is true that the orders of the Department of early date, requiring practice at sea, are now much respected by the officers, and executed with unusual fidelity; and Captain Ingraham, the Chief of the Ordnance Bureau, states that "the reports from commanders of squadrons, and single ships, continue to show great attention on the part of the officers to the general preparation for battle, and to the instruction of the men in practical gunnery, and afford evidence that the armaments and ordnance equipments of our vessels are efficient and satisfactory;" still, I believe it is conceded by all officers that some system is needed to improve this part of the service. Surely no man-of-war should go to sea without a certainty of having a supply of seamen qualified, by training, for being captains of guns; and, in my opinion, a vast improvement would follow if none went to sea without an officer designated especially as the ordnance officer of the ship.

An effort is now being made to initiate a system as far as it can be done in the absence of legislation. The Plymouth sloop-of-war is now at the Washington navy yard, placed under the command of Commander Dahlgren, and is being fitted out thoroughly for the purpose of a "Gunnery Practice-Ship." A few officers at present, and a number of select seamen, will be assigned to her, and she will bear an experimental armament of heavy and light guns. Under proper regulations and training, the hope is

confidently indulged that this practice-ship will annually turn off seamen thoroughly trained to the management of heavy ordnance in storm and in calm, and that our men-of-war may be supplied with officers and men familiarized with all the appliances of these great engines of destruction. I commend this subject to special consideration and encouragement, and have no doubt that, when enlarged and aided by the suggestions of experience, this gunnery practice-ship will prove an invaluable acquisition to the service.

The recent changes in the armament of our vessels call for a somewhat detailed statement from the department on that subject. In many of those most remarkable conflicts in which the American navy won its proudest trophies, it is well settled that the superiority of the calibre of our guns contributed very much to the successful overpowering of the formidable adversary,

In consideration of the comparative strength of our naval force, it becomes vastly important that we should call into exercise the inventive and suggestive genius of our countrymen; and strive not merely to keep pace with, but, if possible, in advance of others in the character of our engines of destruction in war. In this matter the Ordnance Bureau has not been idle. The progress in improving, modifying, and enlarging the guns of the service has been cautious and gradual, yet steady and impressive.

The experimental establishment at the Washington navy yard has been for many years an admirable adjunct to the bureau. Having at its head an officer of a high order of intellect and indefatigable energy, aided by a small corps of assistants, the department has found it a shield of protection against the introduction of the novelties of visionary inventors. No innovation has been recommended until subjected to the severest tests; yet progress, and an eagerness to be in the foreground of improvement, have been manifest. The recent adoption on the new frigates of the 9, 10, and 11-inch shell guns to the exclusion of shot, was by no means inconsiderately or hastily made.

It was suggested by Commander Dalghren, in 1850, that he could "exercise a *greater* amount of *ordnance power with a given weight of metal*, and with more safety to those who manage the gun, than any other piece then known of *like weight*."

Commodore Warrington, then at the head of the Bureau of Ordnance, ordered the guns proposed. The proving and testing continued during the years of 1852, 1853, and 1854. The points of endurance and accuracy were specially examined. The first

gun stood 500 rounds with shell and 500 with shot, without bursting; and subsequently other guns were proved to the extreme, and endured 1600 and 1700 rounds without bursting. Shells have been adopted because they are deemed preferable, not because of any apprehension that shot cannot be used in these guns with perfect security, that point being settled by actual experiment. This fact is said to be attributable to the circumstance of there being thrown into the breech a very considerable additional weight of metal. If, therefore, it is at any time contemplated to attack the solid masonry of fortifications, several feet in thickness, solid shot can be used, although recent developments in the late European wars will hardly encourage such assaults to be often undertaken. It is probably true, as alleged, that as solid shot are driven by a larger charge of powder their power thereby is proportionally greater; and that on striking a ship they may pass entirely through her, thus exposing her to the consequences of two serious breeches. These openings made by solid shot, however, are often easily repaired, even during an action; but if a vessel is struck and penetrated by one of these monster shells, which carries within itself the elements of explosion, one can hardly conceive of the crashing of timbers and the havoc and destruction which must inevitably ensue. And thus the work of one shell would be more fatal and disastrous than that of many shot.

In addition to this heavy armament, our national vessels have, for a few years past, been supplied with boat guns—brass pieces, 12 and 24-pounders. They are truly formidable, and, under the management of trained men, are often discharged ten times in a minute. They are so constructed, as to be easily placed in small boats, which can thus enable an approach to the enemy at points inaccessible to the large vessel, and when landed can be managed with facility and fatal effect. The reports of their great service recently in China, very forcibly illustrate their great advantage as a portion of a ship's armament.

But I forbear to pursue this subject, leaving it in the hands of able ordnance officers. The cautious and sound judgment of the late Commodore Morris approved the new ordnance. The six new frigates presented at once the question of supplying them with the guns after the usual old model, or in accordance with the suggestions of our able ordnance officer, tested by years of much consideration. After investigation, I unhesitat-

ingly sustained the recommendation to fit out the new frigates with their present formidable battery. It is true the guns are very heavy, but experience and practice, and the aid of labor-saving inventions daily made, will render them as manageable as 32-pounders were twenty years ago.

* * * * * * * * * * * * *

J. C. DOBBIN,
Secretary of the Navy.

To the President of the United States.

INTRODUCTORY NOTICE.

EXPLOSIVE projectiles have been variously associated from time to time with the mortar, the howitzer and the cannon. At first they were thrown by hand, and the use of grenades is not yet entirely discontinued; then followed their discharge from mortars, which practice is referred to several periods in the early history of artillery, by different military writers. For instance:—

1376—At Jadra, by the Venitians.—*M. Meyer.*
1521—At the Siege of Mezieres.—*Thiroux*, 49.
1522—At the Siege of Rhodes by the Turks.—*Durtubie*,—*Thiroux*, 49.
1534—Invented in Holland.—*Paixhans*, 350.
1542—At the Siege of Bordeaux.—*Thiroux*, 46.
1580—Used in Holland.—*Paixhans*, 350.

There is good reason, however, to doubt whether the modern bomb was understood and used at the remote epochs thus assigned; or, if it be admitted that a correct idea of it was then entertained, there seems to be a tolerable assurance in the sparse and isolated occasions usually

quoted, that its construction and proper mode of application, were so indifferently comprehended, as to interpose a bar to any useful realisation of its capabilities.

The meaning of the meagre notices left on record, has been much obscured, by the fact that the mortar and grenade were in common use previous to the recognised introduction of the bomb; but the mortar was applied to the projection of huge stone balls,* and the grenades were thrown by hand.† It is indeed exceedingly improbable, that a means of such formidable demonstration as the modern bomb, would have been abandoned or neglected at the periods above stated, to the extent that the exceedingly exceptional application of it implies, if anything resembling it had been, or was likely to be, attained: for Europe was then desolated by war, the defence of fortified places was at least on a par with the attack, and an auxiliary so promising as the bomb, would certainly have been employed if available.

The first well known exhibition of its powers, was followed by an immediate adoption of the bomb throughout Europe; this occurred in the contest maintained by the United Provinces of Holland, against the intrusive and oppressive prerogative of the Spanish Crown. The army of the Federation had, by reason of many con-

* Timmerhans, p. 12. † Thiroux, 46, Bonaparte.

curring circumstances, been brought to a high degree of excellence under the leadership of the Nassau Princes, and its condition and operations were regarded by the military world, as illustrative of the most advanced state of warlike science in that day.

Previous to the truce of 1609, no instance occurs in which the bomb was resorted to, though it is plain that about this time its construction and functions had been carefully studied, and the details matured.

For in 1606, St. Julien published in Holland, his "*Forge de Vulcain*," in which, among other matters pertaining to artillery, he notices the bomb, and gives various particulars concerning it; from this work the following table is quoted:—

Calibre of Mortars.	Diameter of Bombs.	Weight of Empty Bombs.	Powder Contained.
19½ in.	19 in.	529 lbs. *Avr.*	51¾ lbs. *Avr.*
13½	12⅞	140	16⅙
8½	8½	37¾	4⅓
6⅞	6⅞	21½	3¾

It is also observable, that the work of the Engineer, Diego Ufano, who served in the Spanish army previous to the truce, insisted much on the advantage of mortars for projecting stone balls and other missiles, but does not include the bomb.*

---

* Bonaparte.

When the truce expired and hostilities were renewed, bombs were not employed by the Spaniards in the siege of Berg-op-Zoom, (1622,) nor of Breda, (1624.) Their first well authenticated use was by the Dutch Prince, Henry of Nassau, in 1624, at the siege of Grol; the results must have been considered highly satisfactory, inasmuch as a more extended application of them ensued at subsequent sieges, and in reducing the Fort of Schink, the Prince employed them exclusively. Their reputation now spread over Europe, and they were soon introduced into the services of other powers.

The unwieldy weight of the mortar and its bomb (for some of the latter exceeded 300lbs. even at this early period) effectually precluded their available use in field operations,—to meet this purpose, light mortars were cast, and acquired the designation of howitzers. It does not appear, that this application of explosive projectiles impressed military men so decidedly with a sense of its merit as the bomb, and it consequently lingered for a long while in comparative insignificance in some countries. In Germany it met with most favor,—in England and Holland the number of howitzers was more limited; in France none were cast until 1749,—(*Thiroux*, 57,—*Meyer*.—*Timmerhans*, 23, 24,)—and, though it is stated by some writers (*Timmerhans*, *Thiroux*,) that the Royal ordinance of 1732, included the 8-in. class of siege howitzers,

this impression is not confirmed by the copy of the ordinance given by St. Remy.

To Frederick, King of Prussia, the howitzer has been indebted for the full demonstration of its capacity: and the important advantages he frequently derived from it, caused a great increase of the number of such pieces in all the services of the Continent.

So far as the mortar and the howitzer were concerned, it cannot be said that explosive projectiles ever constituted a permanent part of the equipment of naval ordnance. The bomb, it is true, has been used occasionally in attacking fortified towns on the seaboard, but never in regular engagements between ship and ship. Its adaption to this purpose is of recent origin; and it is evident that the naval authorities of every country are more or less impressed with the importance of the new weapon, inasmuch as there is hardly an armed ship of any nation that is not provided with shells, and cannon cast expressly of large calibre for their use.

Should the horizontal fire of shells prove to be as formidable against shipping as generally supposed, it is difficult to conjecture what revolutions it may occasion in sea engagements. No doubt the experience of the actual conflict will point out improvements in the shell itself or in the manner of using it, and set at rest some of the issues that have been raised in regard to the merits of particular devices and systems; though

on the whole, the long period of peaceful relations that has subsisted between the great maritime powers, has been favorable to a careful study and disposition of the details required to give effect to the naval shell; quite as much so as the twelve years' truce in Holland was to the development of the bomb in the seventeenth century.

When the bomb was first introduced, its projection from the mortar was confined to high angles of elevation. After Marshal Vauban had so triumphantly vindicated, by actual trial, his project of ricochetting shot from them, and demonstrated its advantages in the attack of fortified places, General Lafrézélière essayed the application of this practice to bombs. The success of the experiment induced the casting of the first French howitzer (8-in. siege) especially for the purpose, (*Paixhans*, note, 386;) and it is probable that ricochet practice had also been the more common habit with the howitzer in other services.

To ensure the reflection of projectiles from the soil, it was necessary to fire them at a much lower angle of elevation than usual with mortar practice, though the elevation was still beyond that used for cannon; the fire therefore was not what is commonly termed direct or horizontal, and lower charges were also employed, so that the shells rolled along the ground, exploding above its surface, and this continued to be the

custom so long as the short howitzers of that time were in vogue.

Soon, however, appears to have been suggested the idea of firing shells like shot, horizontally, or at angles not varying materially therefrom; and the object in view seems to have been chiefly to operate on shipping. A trial of the kind is recorded as early as 1756, at Gibraltar, and the idea is also suggested by Gribeauval, in his memoir on coast defence.* In 1795, a trial on a timber target was made at Toulon with 18-pdr., 24-pdr., and 36-pdr. shells. In 1797, 24-pdr. shells were fired experimentally into a small vessel at Cherbourg. In 1798, we have the inquiry prosecuted on a large scale at Meudon by a special commission; in the course of which 36-pdr. shells were fired at a target representing the section of a line-of-battle ship, at distances of 400 and 600 yards; 24-pdr. shells were also tried, and the results produced such an impression on the mind of General Gassendi, who was a member of the commission, that he immediately wrote an account of the trial to Bonaparte, (April, 1798.) In 1803, General Lariboissière, at Strasbourg, made some practice upon a timber target, placed 300 yards from a 24-pdr. cannon; the shells were fired at it with 6lbs. charges, in the presence of many general officers.

* In 1782, shells were used from the British batteries against the celebrated floating batteries, but they seem evidently to have performed a subordinate part to the hot shot.

Meanwhile, the same object had been incidentally approached in England in the course of prosecuting another purpose. In 1774, General Robert Melville invented the *Smasher*, and some ordnance of this description was cast by M. Gascoigne, the manager of the well-known private foundry at Carron. The leading purpose of the inventor of the *Smasher*, was to fire 68-pdr. shot with a charge as low as one-twelfth its weight, and thus to effect a greater destruction in a ship's timber by the increased splintering which this practice was known to produce,—hence the gun was called a "*Smasher*." The use of shells, hollow shot and carcasses, was also suggested by General Melville.

The first piece of the kind was cast in 1779. It weighed 31 cwt.; the shot, 68 lbs.; charge, 5½ lbs.; length of bore, 48 in.; diameter, 8 inches. There is now in the possession of General Melville, a small model of this gun, with the following inscription:—

"Gift of the Carron Company to Lieutenant-
"General Melville, inventor of the Smashers and
"lesser Carronades, for solid, ship, shell and car-
"cass shot, &c. First used against French ships
"in 1779."

Carronades of smaller calibre did not enter into the original plan, but were subsequently cast by the Carron Company, in order to adapt them to privateers and letters-of-marque, and

thus create a market for the products of the foundry. Shells were tried from the "Smasher" on several occasions, particularly in 1780, at Languard Fort, by order of Lord Townshend, Master-General of the Ordnance; though in the following year, when General Melville himself experimented before the Duke of Richmond, Master-General of Ordnance, he fired no shells, but only hollow or cored shot, seemingly to remove some impressions against them, in case solid shot of that calibre were found too heavy for convenient use at sea.

It will be perceived, that the idea of General Melville included incidentally all the elements of a naval shell system. The bore of his "Smasher" or 68-pdr. carronade, was of convenient size, being of 8-in. diameter, like that of the shell-gun now in vogue.

The use of shells entered into the first design and was made the subject of experiment, but was considered by the inventor, and by the officers of the navy generally, as a subordinate feature in the plan, and far from important. The prominent idea of projecting balls of a maximum volume with a minimum velocity, overrode and excluded every other consideration. This of itself was manifestly as great an error as the minima masses and maxima velocities of the long gun system, to which the carronade was thus directly opposed, and the consequence was,

that it gradually fell into disrepute, and, after a varying reputation of fifty years, has been abandoned.

The redeeming trait in the project of General Melville, which, if properly appreciated and developed, might have anticipated the Paixhans system by half a century, was so little thought of, that the suggested application of explosive projectiles, hardly went beyond the first essays. It may be supposed that this course was due to policy, and that the British government purposely ignored the shell, avoiding its development as a needless addition to a naval superiority already sufficiently established.* But the difficulty in the way of this supposition is, that the Admiralty accepted any part of the proposition at all. It would have been far easier to suppress the whole project in the germ, by making its concealment of greater interest to the inventor, than its prosecution, instead of adopting it in

* "So long as the maritime powers, with which we were "at war, did not innovate by improving their guns, by extending "the invention of carronades, or, above all, by projecting shells "horizontally from shipping; so long was it the interest of Great "Britain not to set the example of any improvement in the Naval "ordnance, since such improvements must eventually be adopted "by other nations; and not only would the value of our immense "material be depreciated, if not forced out of use, but a probability would arise that these innovations might tend to render "less decisive our great advantages in nautical skill and experience. Many of the defects which were known to exist, so long "as they were common to all navies, operated to the advantage "of Great Britain."—(*Simmons, page* 2.)

part and thus pointing out the course to the remainder. So far, however, from pursuing any half measures in the matter, we find that a disposition was manifested at the first adoption of the carronade, to carry its application as far as possible. Thus in 1782, the *Rainbow* was armed entirely with such pieces, viz., 20 *smashers* or 68-pdr. carronades; 22, 42-pdrs., and 6, 32-pdrs.* In 1796, the *Glatton* had *smashers* for the entire battery of her lower deck, and is said by their means to have beat off, with great loss, a French squadron of three frigates and three corvettes.† It happened also, that in 1782, the *Cambridge*, 80, then one of Lord Howe's fleet, was provided with carcasses for her two *smashers*, and fired them while engaging the combined fleet, then endeavoring to prevent the English from relieving Gibraltar.‡ The shell itself must also have been furnished to some of the English ships; for in 1799 they were fired from the "*smashers*" of the *Tigre*, 74, into the French storming columns at Acre.§ In the course of the same operations, the *Theseus*, 74, suffered most severely from an accidental explosion of some of

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* This vessel caused the French Frigate *Hebe* (18-pdrs.) to surrender at the first broadside, Sept., 1782.—*Allen I.*, 347.

† Allen, 431. ‡ (Ekin's Naval Battles.)

§ "Two 68-pdrs. mounted in two djerms lying in the mole, "under the direction of Mr James Bray, carpenter of the *Tigre*, "threw shells into the centre of the enemy's column with destruc- "tive effect."—(*Allen I., page* 509.)

her own shells;* but these are said to have been taken from a French prize.

It is certain too, that when the war commenced with the French Republic, the asserted supremacy of England on the seas, had not been so fully established as afterwards by the victories of Trafalgar or the Nile; and it was far from being foreshadowed by the indecisive combat of June, 1794. There seems to be no ground for the belief, considering the great stake supposed to be at issue, and the general feelings which imbittered the contest, that the Admiralty would have been content or justified, to Crown or Country, in waiving any advantage that might occur from resorting to improvements in offensive means. Moreover, it could not have escaped their vigilant observation, that the French were

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* "The *Theseus*, on the 14th of May, at 9 h. 30 min. A. M., dis-
"covered the squadron of Commodore Perrèe, off Cesarea, and was
"about to make sail in chase, when a dreadful explosion of twenty
"36-pdr. and fifty 18-pdr. shells took place on the poop of the
"Theseus. Captain Miller was killed by a splinter; the school-
"master, two midshipmen, 24 seamen, and 3 marines killed, and 47
"persons wounded, including a lieutenant and midshipman, the mas-
"ter, lieutenant of marines, the surgeon, chaplain and carpenter;
"making a total of 78 killed and wounded. The whole of the
"poop and the after part of the quarter-deck, were blown to
"pieces, and the booms shattered. Eight of the main-deck beams
"were broken, and all the ward-room bulkheads and windows
"destroyed; but the fire was subdued by the exertions of Lieu-
"tenants Thomas England and Summers. In the disabled state
"of the Theseus, it was a matter of gratulation that the French
"Squadron did not attack her."—(*Allen*, 511-12.)

prosecuting this very inquiry, and that it behoved them to be first on the track.

Be this as it may, it is undeniable that the idea of using shells as a naval means, did not receive from the carronade, that development and expansion which could warrant its being considered as a system; and so little attention did its early exhibition attract, that it is difficult to trace out the few cases in which it was partially resorted to in service, or for experiment. It was, at best, little more than a vague conception; its formidable powers unrealized, unnoticed, were doomed to lie dormant for nearly half a century after the carronade was invented, and only attracted the attention of the naval world when the system, in which it was designed to enact an insignificant part, was falling into disuse.

For more than the third of a century the idea of firing shells horizontally, had been entertained by some of the most prominent artillerists of the day, and it had been sufficiently tested to prove that a means of offence was at disposal which, for naval purposes, was more destructive than any other known. The experiments in France on targets at Toulon, Meudon, Strasbourg and on a small vessel at Cherbourg; in England in 1798, and in actual service by that power in 1799, (at Acre,) were most conclusive of the capacity of shells, and of the practicability of using them.

But these elements of a mighty agent thus revealed were without consequence, without impression on the naval world; for they were uncombined, and needed the workings of a master spirit to evoke the terrible energies of which they were capable.

We believe the claim to this distinction is, by common consent, awarded to General Paixhans, and the present naval shell system is everywhere admitted to derive its origin from that eminent artillerist.

The sole object of this system is, the horizontal projection of shells from the batteries of ships; and the idea is not only closely interwoven into the whole texture of the proposition, as elaborated in the publications made by Paixhans in 1821, '22, and '24; but it is also stated particularly, and in order that this fact may have its due weight, the words of the author will be quoted:

"Of all the improvements tending to increase "the effects of present naval ordnance, that "which will give incomparably the greatest "power, will be the disuse of solid shot, and "the substitution of hollow shot loaded with "powder so as to explode." (Page 26.)

Page 78. "And we shall not only make it "appear how shells of heavy calibres, such as "48 and 80 may be fired with effect far superior "to 18, 24 and 36-pdr. shells, but we shall de-"monstrate that far from being limited even to

"this powerful fire, the effects of sea artillery "may at once be increased (by firing with power "and accuracy, like ordinary cannon-shot, the "largest bombs, of such calibres as 150 and "200,) to a degree of intensity not anticipated "and which will be decisive; to which we shall "add some improvements that relate to increas- "ing the destructive effects of the bombs them- "selves."

It is not intended to assert that to Paixhans is due the discovery or invention of each or of any of the numerous details that constitute the system; but his is the merit of assembling and judiciously arranging the scattered elements into one whole, so that the adaption of the shell to a new field of action became, not only practicable, but we may say unavoidable.

"Nous n'avons donc rien inventé, rien innové, "et presque rien changé; nous avons seulement "réuni des élémens épars, auxquels il suffisait "de donner, avec un peu d'attention, la grandeur "et les proportions convenables, pour atteindre "le but important que nous nous etions proposé." (Page 230.)

It was not a mere suggestion that shells *might be* fired directly like shot, but the means of instant execution were furnished with a critical minuteness very rare in a plan as comprehensive; so that it only remained to follow the various conditions prescribed, in order to develop at once the power of the agent in question.

To the singularly complete manner in which the task was accomplished, and the universal acceptance which it received from the principal naval authorities of the world, may be attributed the uncommon uniformity which appeared in the "*Nouvelle Arme*," whether used by one power or another. Wherever introduced on shipboard, the shell-gun was recognisable, by its peculiar form and straight muzzle, from every other piece in the battery,—and, being the only evidence of the new system's constituting part of a ship's force that could not be kept from view, but stood out prominently, so as to attract the attention even of the casual observer, it was natural that it should come to be used to designate the system of which it was so conspicuous a part; and hence the prevalence of the phrase "*Paixhans gun.*" But from being merely a brief and convenient expression for the essential element, it finally came to be considered as embodying the main purpose of the inventor, when, so far from having any proper claim to this consideration, the peculiarities that distinguished it from other guns are not even necessary to the development of the power itself, but only a commodious form for its advantageous application. It is by no means indispensable to horizontal shell firing that the precise contour or class of gun prescribed by General Paixhans should be followed. On the contrary, shells may be, and are used from every class of guns mounted in ships of war; the very

external peculiarities that distinguish the original shell-gun, have been discarded in the later ordnance of the kind made for the French navy, (22 cent. of 1842 and 27 cent.;) and with even more important departures in those made for the United States navy, (8–in. of 55 cwt. and of 63 cwt.,) and for the British navy, (8–in. of 65 cwt.). It is certain that the important characteristics of the pieces, proposed by General Paixhans, were not the offspring of mere caprice, anxious to impress upon a design patent evidence of invention by differing from all else of the kind; on the contrary, they were dictated by mature experience, and the soundest judgment, as affording the relative proportion of metal, and the interior construction best adapted to develop the power of the system proposed. It is true, that material differences have been made, as already stated, in the pieces designed especially for shell service in the navies of Great Britain and the United States; but it remains to be seen whether the changes are for the better or worse, and it is certain that one of the ablest English writers* on ordnance of the present day states very decidedly his preference for the canon-obusier of 80, to the English 8–inch, as we shall have occasion to notice more at length presently.

Being after all but an accessory to another purpose, these pieces do in nowise conflict with

* Simmons.

the claims of any other artillerist to a peculiar form of gun. The interest of those whose names are associated with carronades, the Congreve gun, or Colombiad, are not therefore abated by the fact, that to complete and perfect his general plan, General Paixhans deemed it requisite to economise the metal of pieces for throwing shells, by a certain distribution, so as to ensure the facility of having the projectiles as large as possible. With the former, the use of shot was contemplated partly or entirely, and their proportions therefore necessarily differed from those of pieces which were *solely* for shells.

From the very natural interpretation of the common phrase, "*Paixhans gun*," identifying the name of the author of the system with a subordinate feature only accessory to the main design, some misapprehension of the true principle of the "*New Arm*" has arisen, which time will no doubt correct.

We are also inclined to believe, that by accepting too literally the English rendering of the term "*boulet creux*," an intention has been attributed to Paixhans of using uncharged shells, for which no warrant can be found in any part of his system as promulgated by himself. A writer, whose "Ideas on Heavy Ordnance" are justly recognised as embodying most valuable views, thus expresses himself in this matter:

"Col. Paixhans at first, with much discretion, "proposed that his guns should project *hollow*

"*shot;* he evidently feared to shock long-estab-
"lished prejudices, by at once proposing charged
"shells." (77.) In the very first announcement of his project which Paixhans made to the public, (*Nouvelle Force Maritime*, 1821,) he applies the term *boulet creux* to the projectile in question, but he distinctly states that this *hollow shot* is to be "*chargé de poudre et d'artifice*," (21;) on the next page the word *hollow shot* again occurs; but these are to be "*bien faits avec de charges de poudre;*" and at 78, the *hollow shot* are to be "*chargés;*" and we are not aware of a single passage in any of the writings of Paixhans which, directly or by inference, favors the supposition that his *boulet creux* were intended to be uncharged. So of other French authorities. Colonel Charpentier, for instance, expresses clearly in what sense he understands boulet creux to be generally accepted:

(147.) "And to avoid all confusion by the
"denominations *hollow shot* (boulet creux) and
"howitzer shells, the first of these will be applied
"to the hollow projectiles specially designed for
"the Navy, and the latter to the hollow projec-
"tiles common to the land and sea services."

(164.) "The advantages of hollow projectiles
"are now too generally conceded to require any
"demonstration. By these fragments, dispersed
"in every direction," &c., &c. The land service
"use howitzer shells, the Navy uses "hollow
"shot," ("boulet creux.")

(303.) "The service charges for hollow projec- "tiles are thus regulated," &c., &c.

Then follows the classification into bombs for mortars, and hollow shot ("boulets creux") for the guns, &c., &c.

Again, in the Aide Memoire Navale, the term translated "hollow shot" occurs thus:

Page 66. "Les boulets creux ont un trou de "charge par lequel on introduit la charge quand "les projectiles sont ensabotés."

Pages 67, 68. Tables of boulets *pleins* and boulets creux; the latter for cannon, canons-obusiers, and carronades.

Page 270. Charging of the "boulets creux."

In experimenting on the project of Paixhans, (1824) "boulets creux" were subjected to comparison, but it is distinctly stated that they were loaded; and the application of the term by the committee seems to have been designed for the shells of ordinary cannon, 24-pdrs., 36-pdrs., &c.

It appears, therefore, that by the term—translated literally—"hollow shot," it was not intended to convey the idea of an uncharged shell.

As to the use of hollow shot uncharged, it may be remarked, that Captain Simmons has set that fully at rest; indeed, it would be difficult to controvert his argument against the use of hollow shot, or, to speak more plainly, uncharged shells, in lieu of solid shot. And, even admitting that peculiar circumstances might confer an advantage of any kind upon the hollow projectile, it

seems unaccountable that the cavity should not be filled with powder, and thus a greater power conferred, in nowise prejudicial to the supposed merits of the shell when unloaded.

The use of hollow shot was the obvious defect of the carronade system, and so well confirmed by experience, as to lead to the projectiles being discarded. The substitution of solid shot was afterwards found inconvenient in pieces of insufficient inertia, and led to the final disuse of the carronade itself.

In the recent Regulations of the U. S. Navy, there is no such projectile recognised as "hollow shot."

I.

DIMENSIONS AND RANGES OF U. S. NAVY CANNON.

Armaments of U. S. Ships established in 1845.—Modified in 1853.—New Batteries, 1855-56.—Armament of Steamers.—Dimensions of U. S. Cannon.—Projectiles.—Ranges of 32-pdrs. of 27 cwt., 32 cwt., 42 cwt., and 57 cwt.—8-inch Shell-Guns.—Remarks.

THE ships of the U. S. Navy are armed with 32-pdrs. and 8-in. shell-guns of different classes, as determined by a Board of Captains convened in 1845.

By this Regulation there were established six descriptions of 32-pdrs., classed according to their weight, viz.: of 57 cwt., (or long gun,) of 51 cwt., 46 cwt., 42 cwt., 32 cwt., and 27 cwt.; and two classes of 8-in. shell-guns—63 cwt. and 55 cwt.

The first-class frigates carry 32-pdrs. of 57 cwt., and four 8-in. of 63 cwt. on the gun-deck, with 32-pdrs. of 32 cwt., four 8-in. of 55 cwt., and two 32-pdrs. of 51 cwt. (for chase,) on the spar-deck. One or two of the heaviest ships have 32-pdrs. of 42 cwt. on the spar-deck. The 32-pdr. of 46 cwt. was only designed for a few frigates of inferior rate.

Sloops of war are armed according to their

size: the largest with 32-pdrs. of 42 cwt. and 8-in. of 63 cwt.; the next with 32-pdrs. of 32 cwt., and 8-in. of 55 cwt., and the smallest with 32-pdrs. of 27 cwt.

In 1853, a Bureau Regulation, approved by the Navy Department, excluded the 32 of 51 cwt., and 8-in. of 55 cwt. from the Armaments of Frigates, and directed that ten 8-inch of 63 cwt. should be carried and collected in one division on the gun-deck.

Line-of-battle ships have their gun-decks, whether two or three, and their spar-decks, armed respectively like those of frigates.

Since January, 1856, some of the ships have been armed in another manner, and the batteries of the recent screw frigates are composed of new ordnance, differing in calibre and construction from the guns previously used. No account of them has yet been published by authority.

The pivot-guns of the U. S. Navy are the 64-pdr. and the 10-in. shell-gun of 86 cwt.

The 64-pdr. differs in no material particular from the English 68-pdr., except that the U. S. gun has a bore of eight inches, and the British gun has a ball very nearly of the same dimensions, the latter is, consequently, about one-tenth of an inch larger than the American and proportionately heavier.

The largest steamers carry the 64-pdr., and some of the inferior classes the 10-in. shell gnu. The new Razee Corvettes, Constellation and

Macedonian, have one of the latter on the forecastle and stern.

The largest steamers have the 8-in shell-gun of 63 cwt. in broadside, and those of inferior class the 8-in. of 55 cwt.

The U. S. Naval shell-guns are of two patterns. The 10-in. of 86 cwt., and the 8-in. of 63 cwt. cast previously to 1851, follow the form prescribed by Paixhans; they will be easily recognised by the straight muzzle common to the French canon-obusier of 22 cwt., and have no sight masses; they are not turned on the exterior, consequently retain the outer crust, which gives them a rough appearance.

In 1851, some new 8-in. shell-guns of 63 cwt. were cast, of the same length of bore as the other patterns, but following the external form of other recent Navy cannon. They are turned, have sight masses, a bell muzzle, and a stouter knob.

The 8-in. of 55 cwt. was not introduced until after 1845. It resembles the new 8-in. of 63 cwt. in external shape.

DIMENSIONS, &c., OF SHOT AND SHELL GUNS OF U. S. NAVY.

(*From Regulations of Bureau of Ordnance*, 1852.)

Class.	Weight in cwts.	Date.	Length extreme from muzzle to rear of B. Plate.	Bore.		Charges.			Weight of	
				Length.	Diam.	Dist.	Ord.	Mean	Shot.	Loaded Shell.
			inch.	inch.	inch.	lbs.	lbs.	lbs.	lbs.	lbs.
32-Pdr.	27	1846	76.6	68.4	6.40	4	4	3	32½	26½
	32	1846	84.0	75.10	"	4½	4½	4	"	"
	42	1847	101.2	92.05	"	6	6	4	"	"
	46	1846	107.44	97.2	"	7	7	5	"	"
	51	1846	113.4	104.0	"	8	7	5	"	"
	57	1846	117.6	107.9	"	9	8	6	"	"
8-inch.	55	1846	105.7	95.4	8.00	7	7	6	.....	51½
	63	1841	111.5	102.0	"	9	8	6	.....	"
	63	1851	112.01	100.3	"	9	8	6	.....	"
10-inch.	86	1841	117.0	106.0	10.00	10	9	8	.....	106
64-Pdr.	105	1849	137.0	124.2	8.00	16	12	8	63¾	51½

The "length extreme from *muzzle to rear of breech plate*," in the fourth column in this table, gives the real length of gun, excluding the pomilion, which is a mere appendage. The length generally given is measured from the base ring to the face of the muzzle, which does not include a very material portion of the metal necessary to the structure of the piece, and may also vary considerably in different cannon.

The difference between the two dimensions, length of gun as given here and length of bore, furnishes a very important item, viz.: *the thickness of metal rearward of the charge.* This is not always to be had by the ordinary tables of dimensions.

PROJECTILES.

By Regulation, shot and shells which do not vary more than two-hundredths of an inch,* more or less, from the prescribed diameter of any calibre, are received.

In the practice for range, shot and shells were selected, not more than one-hundredth of an inch in excess or otherwise; hence it is probable that they represented the mean of a large number with tolerable correctness.

The average weight of 32-pdr. shot is 32½ lbs., and of 64-pdr. shot 63¾ lbs.

The average weight of 110 8-inch shells thus chosen from several thousand cast for service was found to be 50.03 lbs; while the average weight of 4,134 shells of the same description, inspected by me for the general service, averaged 49.8 lbs. The content of powder is about 1.85 lb.

The weight of 10-inch shells averaged 102 lbs., and the content of powder is about 4 lbs.

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* Until 1852, three-hundredths were permitted.

RANGES OF U. S. NAVAL CANNON.

By Lieut. J. A. Dahlgren.

These were reported by the order of the Bureau of Ordnance, and published in the General Instructions issued by its authority for the use of the Navy, 1852.

The ricochet, obtained with the ranges, is now added.

RANGES OF SHOT

FROM THE

32-Pdr. of 27 cwt.

Mounted on Spar-decks of 3d class Sloops-of-war.—Bore of Gun, seven feet above water.—Charge 4 lbs.

Elevation.	Fired in 1st grade.	Grazes on the water.					Extreme roll of ball	No. of rounds.	No. of rounds forming the Mean.
		1st	2d	3d	4th	5th			
	°	Yds.	Yds.	Yds.	Yds.	Yds.	Yds.		
P. B.	0.7	250	.....	.....	.....	.....	.....	4	4
1°	1.8	545	969	1298	1530	1700	2100 to 2500	5	5
2°	2.6	800	1249	1547	.....	.....	.....	10	9
3°	3.7	1047	not taken		.....	.....	.....	10	7
4°	4.5	1278	1536	1657	.....	.....	.....	10	8
5°	5.4	1469	none	.....	.....	.....	.....	10	8
6°	6.3	1637	none	.....	.....	.....	.....	10	9

RANGES OF SHOT

FROM THE

32-Pdr. of 32 *cwt.*

Mounted on Spar-decks of 2d class Sloops-of-war.—Bore of Gun, seven and a half feet above water.—Charge 4½ lbs.

Elevation.	Flash to 1st graze.	Grazes on the water.					Extreme Roll of Ball.	Number of rounds.	Number of rounds forming the Mean.
		1st	2d	3d	4th	5th			
		Yds.	Yds.	Yds.	Yds.	Yds.	Yds.		
P. B.	.....	287	708	1256	.....	.....	.....	.....	10
1°	.....	581	979	.....	.....	.....	.....	.....	9
2°	.....	857	.....	.....	.....	.....	.....	.....	9
3°	.....	1140	1564	1759	.....	.....	.....	.....	10
4°	.....	1398	1446	.....	.....	.....	.....	.....	9
5°	.....	1598	.....	.....	.....	.....	.....	.....	10

Mounted on Spar-decks of First-class Frigates.

Bore of Gun, fifteen and a third feet above the water.

Charge, 4½ lbs.

P. B.	1.10	366	846	not taken	.....	.....	10	10
1°	2.03	655	1159	1501	.....	.....	.....	"	10
2°	2.88	929	1398	1687	.....	.....	1894	"	10
3°	3.91	1152	1545	1713	1794	.....	1573	"	9
4°	4.91	1385	.....	.....	.....	.....	.....	"	6

RANGES OF SHOT

FROM THE

32-Pdr. of 42 *cwt.*

Mounted on Spar-decks of First class Sloops-of-war.—Bore of Gun, eight and a third feet above water.—Charge 5 lbs.

Elevation	Flash to 1st graze.	Grazes on the water. 1st	2d	3d	4th	5th	Extreme Roll of Ball.	Number of rounds.	Number of rounds forming the Mean.
		Yds.	Yds.	Yds.	Yds.	Yds.	Yds.		
P. B.	"	299	701	1041	.....	.....	.....	5	4
1°	1.76	616	1061	1349	1599	1771	1900 to 2600	10	10
2°	2.8	913	1436	1681	.....	.....	.....	10	8
3°	3.9	1194	1581	1770	1875	1932	.....	10	10
4°	4.8	1420	not taken.			.....	.....	10	9
5°	5.8	1651	not taken.			.....	.....	10	8

Charge 6 lbs.

P. B.	.....	313	731	1040	.....	.....	.....	5	5
1°	1.8	672	1143	1458	.....	.....	.....	10	10
2°	2.9	988	not taken		.....	.....	.....	10	10
3°	4.1	1274	1705	1875	.....	sank 2010	.....	10	9
4°	5.0	1505	1643	1717	.....	.....	.....	10	9
5°	6.0	1756	no ricochet.			.....	.....	10	10

RANGES OF SHOT

FROM THE

32-*Pdr. of* 57 *cwt.*

Mounted on Gun-decks of Frigates.—Bore of Gun, nine feet above water.—Charge, 9 lbs.

Elevation.	Flash to 1st graze.	Grazes on the water.					Extreme Roll of Ball.	Number of rounds.	Number of rounds forming the Mean.
		1st	2d	3d	4th	5th			
		Yds.	Yds.	Yds.	Yds.	Yds.	Yds.		
P. B.	.....	357	782	.....	.....	.....	3400 to 3600	6	5
1°	2.2	770	1310	1622	1930	2060	.....	33	33
2°	3.4	1154	1638	1928	.....	.....	2400 to 2700	8	8
3°	4.3	1449	1792	1962	.....	.....	.....	10	8
4°	5.3	1708	.....	.....	.....	sank 1819	1750 to 1960	10	10
5°	6.6	1932	no ricochet.			.....	.....	10	9
6°	7.7	2144	no ricochet.			.....	.....	10	7
10°	10.7	2731	.....	.....	.....	.....	.....	.....	.....

Charge, 7 lbs.

1°	2.4	759	.....	.....	.....	.....	.....	5	.....
2°	.....	1073	1588	1740	.....	.....	.....	10	10
3°	4.4	1353	.....	.....	.....	.....	.....	5	.....

RANGES OF SHELLS (EXCENTRIC)

FROM THE

8-*in. of* 55 *cwt.*

Mounted on Spar-decks of Sloops-of-War.—Bore of Gun, seven and a-half feet above water.—Charge, 7 lbs.

Elevation.	Time of Flight.	Graze on the water.				Extreme Roll of Ball.	Number of Rounds	Number of rounds during the Mean.	Explosion.
		1st	2d	3d	4th				
		Yds.	Yds.	Yds.	Yds	Yds.			Yds.
P. B.	...	283	not taken.		.....	.....	10	10	.....
1°	...	579	1054	.....	.....	.....	12	10	.....
									10" fuse.
2°	...	869	1517	1815	.....	.....	10	9	2050
3°	...	1148	1732	2015	.....	.....	10	10	2002
4°	...	1413	1847	1965	.....	.....	10	9	.....
5°	...	1657	1754	.....	.....	.....	10	8	.....
6°	...	1866	no ricochet.			.....	12	11	.....
8°	...	2315	no ricochet.			.....	10	8	.....
10°	...	2600	no ricochet.			.....	6	6	.....
		Charge, 8 lbs.							
1°	...	602	1053	....	....	.....	5	5	.....
5°	...	1712	1827	1855	....	.....	5	5	.....
8°	...	2308	....	....	....	.....	5	4	.....

RANGES OF SHELLS

FROM THE

8-*in. of* 63 *cwt.*

Mounted on Main decks of Frigates.—Bore of Gun, nine feet above the water.—Charge, 9 lbs.

Elevation.	Flash to 1st graze.	Grazes on the water.			Extreme Roll of Ball.	Number of rounds.	Number of rounds forming the Mean.	Remarks.
		1st	2d	3d				
		Yds.	Yds.	Yds.	Yds.			
P. B.	"	332	735	960	.....	7	6	
1°	1.89	662	1138	.....	3416	10	8	5 sec. fuzes.
2°	3.07	966	1650	.....	.....	10	8	1200 to 1500 yds.
3°	4.34	1264	1820	2031	.....	10	10	
4°	5.32	1540	not taken		.....	10	9	.....
5°	6.32	1769	1915	.....	1938	10	10	.....

RANGES OF SHELLS

FROM THE

10-*in. of* 86 *cwt.*

Bore of Gun, seven and three-quarter feet above water.
Charge, 10 lbs.

Elevation.	Time.	Grazes on the water.					Extreme Roll of Ball.	Number of Rounds.	Number of rounds forming the Mean
		1st	2d	3d	4th	5th			
		Yds.	Yds.	Yds.	Yds.	Yds.	Yds.		
	.....	.....	.....	.....	.....	.....	.....	.....	.....
P. B	.....	.....	.....	.....	.....	.....	.....	.....	.....
1°	.....	.....	.....	.....	.....	.....	.....	.....	.....
2°	.....	.....	.....	.....	.....	.....	.....	.....	.....
3°	.....	.....	.....	.....	.....	.....	.....	.....	.....
4°	.....	.....	.....	.....	.....	.....	.....	.....	.....
5°	5".5	1533	.....	.....	.....	.....	.....	5	4

The practice of this gun was discontinued by order of the Chief of Bureau, who decided not to use it any longer in the U. S. ships. A new and heavier X-inch shell-gun has since been introduced.

The character of the ricochet depends on the elevation of the gun and on the condition of the water at the time. The most favorable circumstances under which it occurs, are where the angle is least at which the ball strikes the water and the surface of the water perfectly smooth. The shot or shell will then roll 3000 to 3,500 yards, rising but little above the surface,—never as high as the hull of a frigate. At first the bounds are of considerable extent —perhaps 350 to 400 yards between the first and second grazes—they diminish gradually, so as to leave intervals not exceeding 50 yards as they approach the end of the range, and finally roll along the top of the water as if ploughing it. Long before this, however, they are apt to curve off to the right or left from the true direction, so as to make an extreme deviation often amounting to 100 or 200 yards.

The extreme roll is soon affected by the elevation of the piece or the roughness of the water, and likewise the character of the ricochet—for the ball bounds high just as one or the other of these is increased—and the seaman must be governed accordingly; if at the time he cannot spare any force of the ball, the practice should be direct—if he can, he may fire direct or on ricochet—much judgment and care should be exercised in deciding on this.

It was noticed in one instance, while firing in a calm with smooth water, that the length of

the first bound was not quite 400 yards—the ball sweeping close to the surface. A slight disturbance of the water increased it to nearly 600 yards, and the wind rising considerably, made it nearly 800 yards. With this increase the extreme roll fell off and the ball rose higher and higher, at most perhaps more than 50 feet, which would have made the ricochet firing entirely useless.

The ricochet of the larger and heavier projectiles, is always superior to that of the smaller calibres, and the direction is also less affected by the wind.

In all cases, except with the long 32-pdr. (and its full charge) the shot and shells are seen distinctly in the air for a mile at least from the gun—provided the observer is placed near the line of fire.

II.

MODE OF OBTAINING RANGES.

Orders given in 1848 to fit the U. S. Naval cannon with elevating sights.—Compelled to execute the ranges on water.—Instruments required.—Plane-table selected and adapted to the purpose.—Description of new Alidade and mode of use—Sample of results.—Triangulation of the Anacostia to obtain stations for the Plane-table.—Measurement of Base.—Series of triangles. — Details of practice. — Projectiles. — Elevating quadrant — Sample of record.

CANNON of every class used in the U. S. Navy were represented at the Battery, and their ranges on the water ascertained by means of Plane-tables placed along the shore.

The Bureau of Ordnance having determined to equip all the cannon of the Navy with sights, the duty of carrying out its views in this particular was devolved upon me in 1848.

The first information indispensable to proceeding with the graduation of the tangent scales was, however, wanting. No ranges had been obtained of any of the classes of 32-pdrs. introduced by the Board of 1845, and none could be procured, even of the long 32-pdrs., that were sufficiently reliable for the purpose in view.

The preliminary operation therefore, involved a much more arduous and tedious operation than that indicated by the expressed wishes of the Bureau; particularly as it was obvious that the ordinary method of obtaining ranges by measurement on land, was not practicable at this place. For the shores of the stream were so winding, that in few places could a direct line be had extending as far as half a mile. And even then, gun practice on the beach or near it would have alarmed, perhaps endangered the people who inhabited the banks of the stream, or who frequented the wharves in small river craft.

There was no alternative but to attempt executing the ranges on the water, for which the width of the stream, and other circumstances, offered some facilities.

But to do this it would be necessary:—

1st. To select some instrument which was sufficiently accurate and ready of use.

2nd. To triangulate the shores of the river.

The jet thrown up by a ball in grazing the water, though of brief duration, is yet susceptible of being made the subject of observation.

This has been done sometimes by placing buoys at regular intervals along the line of fire, with observers at suitable locations, who, by estimating the distance of the jet from the nearest buoy, could thereby approximate the

range. The obvious uncertainty of such a process made it unsuitable for the present purpose.

In 1843, Major Wade used a contrivance for angular measurements of the lateral deviations of shot and shells. But this was not suited to the means here at disposal, nor to the object in view.

Similar objections existed to the Sextant or Circle. All such instruments required a skilful observer, and even then were necessarily limited to the observation of a single graze, inasmuch as it was always necessary to read off one observation before taking another, and hence it became impracticable in this way for one person to note the rapidly succeeding grazes of a ball in ricochet,—which is of too much interest in naval firing to be neglected.

There is also a manifest difficulty in observing with a reflecting instrument upon an object of such transient duration as the jet of water; and this of itself would probably constitute the most serious objections to using a Sextant or Circle, if time, trouble, or expense were of the least consideration.

Angular measurement also involved the subsequent calculation or projection of the work.

Having then no observers qualified to make angular measurements, or to arrange the results subsequently, and the amount of work being manifestly beyond the physical power of one

individual, it was necessary to contrive some appliance that was sufficiently accurate in operation, convenient in yielding its results, and admitting of use by any person of intelligence and readiness.

It seemed that the ordinary Plane-table might be made to meet these conditions, by adapting to it a convenient Alidade; that used for sighting objects in field work being obviously unsuitable, inasmuch as it was not constructed for quick movement, and therefore could not be aligned with the necessary rapidity upon an object so transient as the jet of water thrown up by a shot. The scope permitted by the field of a telescope, appeared to be also too limited to afford the view sufficient to include the variations in distance to which shot are liable, even when fired at the same angle of elevation.

It only remained to remedy these defects by substituting a proper Alidade, and it then appeared that the Plane-table would offer a reasonable prospect of successfully accomplishing the object in view. In the first place, a person of ordinary readiness and perception could be taught to use it with facility and accuracy. Then the direction once taken, was already projected on the table, could be ascertained at a convenient season subsequently, and verified if necessary; with some practice the observation could also be repeated instantly, so as to follow the successive grazes made in bounding.

The new Alidade may be described as follows:

The flat metallic ruler, resting and moving on the surface of the paper, carries upon it a light, upright column, at the head of which is another ruler having a vertical movement only; its extreme points are fitted with raised sights (a notch and a point) which collimate with the bevelled edge of the lower ruler. At the side of the lower ruler, and about mid-length, is an extension of the metal perforated to receive the head of a pin, the centre of which is to coincide with the bevelled edge of this horizontal ruler.

Near one of the corners of the Plane-table, a small brass plate is countersunk in the wood and tapped, so as to receive a pin about half an inch long and screw-cut, having a milled head, above which is a continuation of the pin two-tenths of an inch in length, turned perfectly smooth so as to permit the lower ruler to pivot about it as a centre.

A point along the shore, the distance of which from the Battery has been ascertained, is selected, so that a line drawn from it towards the place where the first grazes are expected to occur, will be at right angles to the line of fire, or nearly so; and while preparation is being made at the Battery for practice, the observer is sent with a Plane-table to this station.

The table is adjusted with the small metal plate over the stake that marks the station,

levelled, and the screws made to bear as firmly as possible. The observer places his Alidade on the pivot pin, sights carefully on a given point at the Battery, and marks on the paper affixed to the table, the direction assigned by the bevelled edge of the ruler; each of the stakes planted in the line are noted in the same way, and the observer then makes known that he is ready.

On the nearest end of the ruler is screwed a pin with a suitable head for the fingers of one hand, for the purpose of giving the direction. On the farthest end is a thin slide carrying a small lever with a keen cutting point, which is depressed by the action of a spring forcibly enough to make an incision on the paper; the slide is moved to a convenient distance on the ruler, and clamped there by screws.

When the cannon has been loaded and properly directed, a preparatory signal is made at the Battery by hoisting a large white ball, made distinct by being displayed against a black ground; seeing this, the observer brings round the Alidade to the expected direction of the first graze, extends his unemployed hand and presses the lever so as to raise the cutting edge above the paper. The ball is lowered and the gun fired. The instant the jet takes place, the sights of the Alidade are aligned

upon it, and the cutting point of the lever suffered to make an incision in the paper.

A Plane-table is placed rearward of the gun on a prolongation of the line of fire, and by it the deviation of the ball from the line of fire is determined.

The efforts of the person at the Plane-table in the rear to ascertain the deviation at the first graze, were frequently rendered unavailing by the intervening smoke. But as the line of sight from the table for range intersects the line of fire nearly at right angles, the deviations of the projectiles from the line is not sufficient to cause any appreciable error in estimating the distance from the Battery on the assumed line of fire.

The failure, therefore, in this respect, only involved the loss of the lateral deviations, which was remedied subsequently, so far as regarded the more important distances, by the practice at screens through which the shot were fired.

As these deviations were small proportionally to the variations in range, an attempt was made to measure them by means of a Micrometer fitted to a telescope, the fixed wire being adjusted to the line of fire, and the movement of another wire being made to depart from it, right or left, as might be necessary. The faintest smoke, however, even when not entirely impervious to the naked eye, obscured the lenses completely.

If it had been possible to place a table in the line of fire beyond the range of shot, the deviations could have been noted without fail; but the locality put this out of the question.

Very little elementary information is required to perceive that the line connecting the Battery and the station, is a base from which is determined the position of a given point, in the present case a column of water, and that the projection of this base on any scale will enable one to ascertain, in terms of that scale, the distances of the jet from either end of the base; that from the Battery being the one in question.

When the work has been completed, the table is returned to the office, and a projection made of the line of fire from the base formed by the station and Battery; in doing which, the pin used for the Alidade is unscrewed and another substituted which has no head, and screws with the upper surface to a level with the paper; on this the centre is shown by a point. The various stakes are laid down on the line by means of the directions assigned them from the station occupied, and the distances from the Battery thus determined, serve to verify the accuracy of the observer, they having been previously ascertained by the Theodolite.

The grazes are then transferred to the line, and their respective distances read off by a scale, the bevelled edge of which is divided into yards.

The scale found most convenient on a table of ordinary dimensions is $\frac{1}{2400}$. Hence, one inch=200 feet, and 1.5 in.=100 yards; the lowest subdivision=2 yds., but the eye readily estimates to half a yard. The beam-compass used for projecting, reads by the vernier to the hundredth of an inch, and may be estimated to one-fourth of this quantity.

The accuracy which the Plane-table, thus arranged, is capable of, may be exemplified by the following determination of grazes from different bases, one being on each side of the stream :—

Chambered 32-pdr. (32 *cwt.*)

June 1st.		July 6th.	
D	A	B	G
yards.	yards.	yards.	yards.
535	532	1082	1083
539	538	1073	1074
555	556	1076	1074
570	573	1097	1097
516	517	1159	1157
519	517	1098	1097
545	546	1093	1091
519	519	1058	1057
584	585	1069	1069
563	564	1176	1178
544.5	544.7	1098.1	1097. 7

The difference between the means is altogether immaterial, and that occurring in individual cases may be properly attributable to the character of the object, which is not always very clearly defined.

The employment of more complex instruments with a view to closer determinations, would involve the necessity of a more highly instructed order of observers, and the results would probably afford no compensation for the trouble.

The arrangement of the Plane-table as described, places its adjustment and use within the scope of any one of intelligence and precise habits. The observations recorded in this report were made by persons employed in the mechanical department of the Ordnance Workshops, and initiated with a slight preparatory training. As a knowledge of the Plane-table was not within the line of their vocation, it could not be expected that they should have been conversant with the rationale by which the results were to be obtained from its application; but it is certain that in its employment, they manifested a degree of dexterity which it would be difficult to excel. In one case, seventeen grazes in ricochet were taken in succession at one table.

The results are deduced so readily, that it has rarely happened in any case, that the operations were not recorded on the same day on which they were made; and this with slight exception was the work of one person.

In October, 1847, a Plane-table was placed at a convenient point along the shore, while Mr. Clapham, then Gunner, fired a series of shot from 32-pdrs. of 32 cwt. and 27 cwt. The results were sufficient to justify the statement to the Bureau that the project was feasible, and arrangements were made for triangulating the shores of the stream, so as to fix with precision the distances between the Battery and the points that were to constitute the several bases for the Plane-table.

Triangulation of the Anacostia or Eastern Branch of the Potomac.—This small river enters the Potomac in a south-westerly direction, a short distance below Washington. Its southern shore is hilly and much wooded; the northern shore is cleared, and many dwellings and stores are scattered along it; a bluff, but not very high bank, skirts the edge of the shore, along which winds the channel, varying in width, but never exceeding 200 yards.

From the left shore, at the distance of about 1000 yards from the Battery, juts out Poplar Point; beyond which, and distant some two miles is Giesbery Point, marking the junction with the Potomac. At the Point opposite is the U. S. Arsenal, about a mile and a-quarter from the Battery; the view of it partly hidden by a long narrow and uninhabited tongue of land, jutting out from the right or northern shore,

about one mile from the Battery, and known as Buzzard Point.

The entire distance to the Virginia shore from the Battery, is less than four miles, affording range for guns of any calibre. The water is so shoal from the channel along the northern shore, across the whole width of the stream, that the long grass from the bottom extends to the surface and makes it very laborious to force a boat through it, even where the depth of water is sufficient, which in many places it is not at low tide. No interruption, therefore, is experienced from the passage of steamboats and river craft up and down the Anacostia; though it is frequently deemed prudent to delay firing when vessels going down the Potomac are near the direction of the cannon, as they are then about two miles distant and within the roll of heavy shot or shells fired at very low angles on smooth water. The light depth on these extensive flats is convenient, because it admits of planting on them stakes, to which are attached screens for practice.

The only delineations of the shores which could be had, furnished nothing but the outline and the positions of a few prominent objects: they were therefore not available for the present purpose, and it became indispensable to measure a Base, and to determine the points by a series of triangles.

After a hasty reconnoissance, the longest line

convenient to the river was selected by Lieut. Blunt on the southern shore, and a suitable base of verification subsequently obtained in the Navy Yard.

The site of the principal base was not of the best description, lying partly across a low marshy piece of soil which gave much trouble; the remainder was on cultivated ground, and along a smooth beach overflowed at high water.

On the 25th of April, the measurement of this principal base was begun and contined on parts of the 26th, 27th and 28th, as the weather and state of the tide admitted. The remeasurement took place on April 29th and May 1st.

Many unfavorable circumstances interposed, but nevertheless the difference between the two measurements did not quite equal one foot. In one instance a bar was knocked over, and in the remeasurement, fractions of bars were allowed, which should have been avoided as so many sources of error.

First measurement,	2567 .474	feet.
Remeasurement,	2568 .466	"
Difference,	.992	"
Mean,	2567 .970	"

The base of verification was measured on the 22d of April; this lay in the Navy Yard and nearly east and west; the east end but a few feet from the ship house; the west end near an old gun on the wharf, and both ends

in line with Station D., the ground nearly level, firm and unobstructed. The first measurement gave 1010.227 feet, the remeasurement 1010.197, the difference about one third of an inch.

The main series consisted of five triangles well conditioned. The angular measurements were made with a theodolite, (Gambey,) belonging to the Coast Survey, for the loan of which I am indebted to the politeness of Professor Bache.

This operation resulted sufficiently well for the purpose in view; inasmuch as the base of verification proves to be:

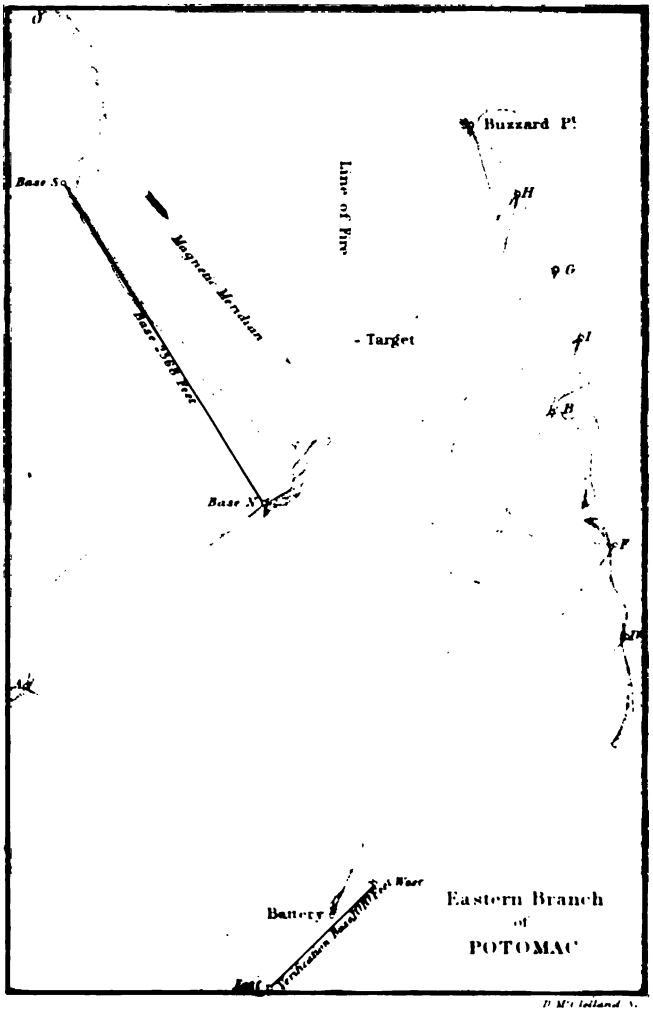
By calculation from principal base, 1010.325 feet.
By two measurements, 1010.212 "

leaving a difference of one inch and thirty-six hundredths.

The Gambey theodolite being required in the Coast Survey, the angles of the secondary points connecting with the main series were measured by a small theodolite of the old English construction, reading no less than 30 sec.

As might be expected, it gave but indifferent angles, though by frequent repetitions the errors in them were reduced sufficiently for the object in view

The measurements of the bases were made by a simple and speedy process. Two wrought iron tubes, purchased for rocket cases, were put on a lathe, and the ends turned with accuracy to


Buzzard Pt
Line of Fire
Base So.
Magnetic Meridian
Base 3500 Feet
- Target
Base N.
H
G
I
B
F
E
A
Battery
Eastern Branch
of
POTOMAC

certain lengths, intended to be ten feet and fourteen feet respectively, though on close examination they proved to be slightly in excess. The tubes were of the best metal, two inches exterior diameter and one tenth of an inch thick, without any perceptible flexure.

Each tube was supported by two stands, that permitted it to have a vertical movement, and was thus made horizontal by means of the level placed on the surface planed for that purpose.

The alignment was preserved by sighting through the tubes in both directions upon the pegs that marked the base. The whole arrangement was of the simplest character.

MAIN SERIES.

Base—2567.970 *feet.*

		°	′	″		″
Buzzard Point,		53	18	14.0		7.8
Base North		60	48	17.75		11.5
Base South.		65	53	47.0	+18″.75	40.7
Buzzard Point-Base N.	2923.5					
Buzzard Point-Base S.	2795.8					

		°	′	″		″
D.		54	18	29		27.6
Buzzard Point,		46	04	57		55.6
Base North.		79	36	38.25	+4″.25	36.8
D —Buzzard Point,	3540.6					
—Base North.	2592.9					

	°	′	″		″
Ver. Base West,	62	44	11.25		04.3
D.	63	17	47.5		40.5
Base North,	53	58	22.25	+21″.0	15.2

Ver. Base W—D. 2359.1
—Base N. 2605.9

	°	′	″		″
A.	65	23	09		7.6
Base North,	70	24	41.75		40.2
Ver. Base West,	44	12	13.75	+ 4″.5	12.2

A.—Base N. 1998.4
—Ver. Base West, 2700.4

	°	′	″		″
Ver. Base East,	85	03	35.62		28.6
A.	21	53	12.75		05.7
Ver. Base West,	73	03	32.75	+21″.12	25.7

Ver. Base East—A. 2592.9
—Ver. Base West, 1010.325

Verification base deduced by triangulation from Base, 1010.325 feet.
By two measurements, (mean,) 1010.212 "
Difference, 1.360 inch.

SECONDARY POINTS.

	°	′	″
B.	94	15	32
Buzzard Point,	43	55	01
North Base,	41	49	27

B.—Buzzard Point, 1954.9
—Base N. 2033.4

		°	′	″		
B.		90	34	26		
D.		51	38	23		
Base North,		37	47	11		
B.—D.	1588.8					
—Base North,	2033.3					

		°	′	″		′	″
Battery Port, No. 4,		56	35	45		35	54
Base North,		60	58	55		59	04
D.		62	24	52	—28″	25	01
Battery.—Base N.	2752.9						
—D.	2716.1						

		°	′	″		″
A.		41	00	16	.5	12
Battery,		100	28	20		25
D.		38	31	09	—14″.5	14
A.—Battery,	2578.1					
—D.	4070.6					

		°	′	″		″
B.		47	57	54		56
Battery,		33	15	54		56
Base North,		98	46	06	—6″	08
B.—Battery,	3663.1					
—Base N,	2033.0					

		°	′	″		″
F.		58	24	30		26
Battery,		46	58	12		08
Base North		74	37	30	+12″	26
F.—Battery,	3116.2					
—Base N.	2362.5					

		°	′	″		″
G.		31	44	30		40
Battery,		29	04	44		53
Base North,		119	10	18	—28″	27
G.—Battery,	4568.6					
—Base N.	2543.2					

		°	′	″		″
H.		24	31	24		30
Battery,		24	00	57		03
Base North,		131	27	21	—18″	27
H.—Battery,	4970.4					
—Base N.	2699.4					

		°	′	″		″
I.		37	42	35		34
Base North,		109	52	48		48
Battery,		32	24	39	+02″	38
I.—Base North,	2412.3					
—Battery,	4232.5					

		°	′	″		″
Buzzard,		36	19	12		08
I.		131	35	42		38
Battery,		12	05	18	+12″	14
Buzzard—I.	1496.4					
—Battery,	5344.4					

		°	′	″		″
O.		31	43	36		28
Buzzard,		121	38	18		10
D.		26	38	30	+24″	22
O.—Buzzard,	3019.0					
—D.	5732.7					

		°	′	″		
P.		32	05	30		34
O.		133	41	48		52
Buzzard,		14	12	30	—12″	34
P.—O.	1394.9					
—Buzzard,	4108.4					

		°	′	″		″
R.		34	56	12		07
O.		112	36	39		34
Buzzard,		32	27	24	+15″	19
R.—O.	2829.2					
—Buzzard,	4866.9					

		°	′	″		″
R.		53	06	42		38
P.		108	38	36		32
Buzzard,		18	14	54	+12′	50
R.—P.	1608.4					
—Buzzard,	4867.3					

The practice was only executed when the atmosphere was perfectly calm.

In order to reduce to the least possible limit the variations in range due to differences in diameters of projectiles, the shells for practice were selected from a large stock, so as to vary but one-hundredth of an inch from the correct diameter, leaving the extreme differences two-hundredths of an inch. They were then carefully weighed, rejecting all that departed considerably from the mean weight, as well as those that were not smooth and spherical. Shells which had no excentric masses, were floated in mercury, and those only used which were similar in the relative position of the heaviest spot to the fuze-hole.

The projectiles thus selected were arranged in the order of weight, and when a sufficient number was obtained to furnish successive sets of ten, the practice commenced with the shell of highest or least weight, taking the others in order.

Like care was given to the size, quality and weights of sabots and straps; the shell being fixed so as to have the fuze-hole, if excentric, and the heaviest spot, if concentric, exactly at an angle of 45°.

The shells were never loaded, save in a few cases of special practice, as the fragments might be dangerous to persons at some distance ashore or on the water—a few ounces of powder sufficed to blow out the fuze without breaking the shell, and the remainder of the cavity was filled with

rice, so as to approach very nearly to the weight of the loaded shell as usual in service.

Primer.—The service primer and perforated hammer were generally used on guns of all calibres.

The Elevation, was obtained by a quadrant made especially for this purpose.

Its principle of construction is simple. It consists of a steel bar about four feet in length: at the end of it is an arc, (12 inches radius,) the index of which bears a spirit level. Outside of this is a smaller level, and inside a bar of 12 inches length, but at right angles to the main bar.

The bar is placed on the lower side of the bore, and entered into the gun until the cross bar coincides with the muzzle face.

The cross level is adjusted to the inferior surface of the main bar, the principal level to zero on the arc.

The exactness with which the new Navy Ordnance are manufactured, ensures the desired means so far as the gun is concerned, and no pains were spared to have the elevating instrument executed in the best possible manner.

The first which was made, failed to answer the purpose. The principal bar was of brass, and unable to support the arc and its appliances; a flexure in it was soon indicated by the standard bar. The divisions of the arc being on silver, were quickly rendered undistinguishable by the

fumes of the powder during practice, so that it became impossible to verify the position of the index after a few rounds,—the motion of the tangent screw was imperfect, &c.

Another one, therefore, became indispensable and was made by Mr. Würdemann. As might be expected from the attainments of this artist, its character is in all respects of the highest order. The arc is divided (on platina) into 5′, and sub-divided by the vernier to 5″. The centering, clamping, tangent movement, interior surface of level, and adjustment of level, graduation, &c., &c., are, in all respects, equal to those of the best instruments for angular measurements of like radius.

Previous to the commencement of the practice on any one day, the quadrant is laid on a standard bar, the cross level adjusted to the inferior surface of the main bar and the index level to zero.

In practice the main bar rests on the lower side of the bore, the cross bar coinciding with the muzzle face. The bubble of the cross level is brought to its place by gently turning the bar around in the gun, which is then raised or depressed until the index level indicates the proper elevation.

(A leaf from the Record.)

PRACTICE WITH 8-INCH OF 55 CWT.

Screen (10 *feet by* 20 *feet*) *at* 550 *yards.*

ELEVATION, 1°.

REGULATION SHELLS, (GAUGES=7.84 IN. × 7.86 IN.,) 5 sec. FUZES.

Dupont's powder; Charge, 7 lbs.—Calm, until the 10th round, when the breeze came up from south-west.—Average height of Axis of Gun above the water, 8 feet.—Average recoil on a level platform, 15½ feet.

Rounds.	Ist grass.	IId grass.	Perforations on Screen.				Remarks.
			Whole No. of grazes.	Above water.	Centre line.		
					Right.	Left.	
	Yds.	Yds.					
				Feet.	Feet.	Feet.	
1	587	1073	7	3.6	.....	8.1	
2	604	1157	9	4.9	1.4	.....	
3	551	1090	10	.....	.....	5.7	
4	547	997	12	.....	.....	.....	
5	593	1051	6	.....	.....	.....	
6	584	1028	12	3.5	.....	8.4	
7	*513	963	12	3.2	.....	.....	Expl'd prematurely.*
8	581	1026	13	.....	.....	0.8	
9	586	1070	15	3.6	2.8	.....	Not seen.
10	571	1011	11	2.4	5.2	.....	
11	*701	1170	12	.....	.....	.....	Expl'd prematurely.*
12	585	1040	10	3.8	4.4	.....	No powder.

Each shell weighed exactly 50.13 lbs. A charge of 0.19 lb. of powder was used to show the action of the fuze without breaking the shell; the rest of the cavity was filled with rice. The powder, rice, fuze and strap of each shell weighed 2.77 lbs., so that the total weight of each shell was 52.9 lbs. The fuze acted duly except in Nos. 7 and 11, both of which took effect at about 200 or 300 yards, and necessarily affected the flight of the shell. No. 9 was not seen. The exact distance where the charges of the shells exploded, could not be determined, the view from the Plane Table being obstructed by a point of land.

* *For which reason the ranges are not received.*

III.

DIMENSIONS, WEIGHTS, ETC., OF SHELLS.

Constituents of the shell which affect its projectile and explosive properties—typified by the French 22$^{cent.}$ and English 8-in.—Concentricity and excentricity, the latter not desirable—but unavoidable.—Rotatory movement first noticed by Robins.—Irregularities produced thereby.—Historical sketch of progress made in ascertaining its cause.—Explained by excentricity.—Mode of action.—Use of it opposed by Paixhans.—Full exposition and experiment by Col. Bormann.—Examined by Paixhans, who advocates the use of it.—Experiments in England.—Sir Howard Douglas not favorable to the use of excentric projectiles.—Experiments in the United States.—Commonly received doctrine of the operation of excentricity on the projectile movement.—The presence of excentricity exhibited by floating in mercury.—On what conditions its quality is dependent—ill effects on the trajectory—by what means best controlled.—Compensating mass—preferable distribution thereof—illustrated by experiment.—Solid shot liable to effects of excentricity—practical illustration.—Conclusion.—Rifle motion—the only useful form of rotatory movement.—Rifles—not of recent origin.—Principles and advantages expounded by Robins in 1745—not understood or followed.—Round ball used.—Difficulties that prevented the adoption of rifles.—Removed by Delvigne, who invented the "*carabine à tige*."—Conical ball—had been used in the United States.—Rifle cannon.—Wahrendorf.—Cavalli—description of the Lancaster gun—authentic details wanting—general theory—trial of the gun in 1851—used in 1854 to arm the new steam gun-boats—results of service at Sevastopol and elsewhere unfavorable.—Ranges.—Rifled shot for smooth-bored cannon.

THE shell intended for direct or horizontal firing from cannon, resembles that commonly

used for mortars and howitzers in having three components:—

—The hollow iron globe from which it derives its appellation;

—The charge of powder contained therein;

—The fuze, by means of which the flame from the charge of the gun is received and carried in proper time to the charge of the shell.

The character of the projectile will vary with the relations that exist between the iron shell and its charge. If the former be very thick, the density of the projectile is increased, and with this, its accuracy, range, and power of penetration; but the charge is proportionally diminished, and thus the distinctive element of the shell is more or less reduced. On the other hand, by increasing the cavity of the shell, so that it shall contain a greater charge, the explosive power is proportionally augmented, but the weight of the shell is diminished, and with it the important qualities of accuracy, range, and penetration.

The French and English shells of 8-inch and 22 cent. exemplify the two modes of proceeding, and probably to the utmost extent to which it would be advisable to carry either. The 8-inch could not be made heavier without manifest prejudice to its explosive power; the 22 cent. could not be made to contain a greater charge without the sacrifice of accuracy and penetration in a most injurious degree.

The English shell extends its effects to a greater distance,—but the French shell is more powerful within the range of which it is capable, and it has yet to be satisfactorily proven that the English shell can exercise decisive effect beyond this range.

It is to be borne in mind that in both services the batteries are so constituted by regulation, that the shell-guns only serve as *auxiliaries* to those which are designed as the principal force. They are few in number and are associated with guns assumed to be, whether they are or not, of far greater effect at distant ranges. On this account, the French shell may appear to be better adapted to its purpose, inasmuch as it does not seem advisable to sacrifice any of its peculiar power at decisive distances, in order to perform a feeble and uncertain part at the extreme ranges which are usually considered as only preliminary to an assured issue, and are designed to be reached by the ordnance to which the shell-guns are subordinated.

The number of the shell-guns admitted by regulation into the English and French batteries is, however, so limited, compared to the number of 32-pdrs., that their relative peculiarities will not be very prominently exhibited; and the disparity that may exist between different descriptions of shell-guns will nearly disappear in the general effect of the broadside. It would seem from the opinion of Captain Sir Thomas Hast-

ings, that this is the view taken of the matter by the English authorities.*

Whether the 8-in. shell-gun (of 65 cwt.) be inferior or not to the long 32-pdr., and how far such consideration should qualify the development of its power, will be examined in another place; it is certainly far less powerful than the heavy 64 or 68-pdrs., and when associated with such ordnance, its shell should have the fullest extent of the explosive capacity.

It may be a matter of reasonable curiosity to inquire into the effect which would be produced by modifying the English system after the French, or the French after the English,—adhering in each case to the weights adopted for their shell-guns respectively, viz., 63 cwt. (7,280 lbs.) for the 8-inch shell-gun, and 3,614 k. (7,968 lbs.) for the 22 cent.

Preserving the bores as they are, the weight of the English shell would be decreased by assimilating its proportions to that of the French, and the content of powder increased, but without equalling that of the French shell; while its

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* Inquiry by committee of Parliament.—Examination of Sir Thomas Hastings, the naval member of the Board of Ordnance.

5026. "At this moment, in vessels of the same class in Admiral "Baudin's fleet and Sir W. Parker's fleet (May 1849) in the "Mediterranean, the armament is as nearly equal as may be? "*Yes.*"

5028. "But, generally speaking, the French fleet is armed with "guns of equal calibre and hollow shot? *Yes, they may be taken* "*as equal powers.*"

previous advantages in regard to force and accuracy, would be sacrificed, one or both, with any arrangement of charge.

On the other hand, to preserve the present diameter of the French shell, and increase its thickness proportionally to that of the English shell, would add materially to the weight of the projectile, and might necessitate a reduction of the charge; thus enfeebling the force and penetration considerably, which are already low enough, and with a positive loss also in the explosive quality.

It is manifest, therefore, that it would not be advisable to make the shell of either nation conform to the proportions of the other, supposing the ordnance to remain unaltered.

Again, if the English shell-gun were bored out so as to receive a French shell, the charge appropriated to fire the latter from the 22 cwt. must be reduced yet more, because of the inferior weight of the English piece; hence less accuracy and force: indeed, such an operation would merely transform the 8-inch of 65 cwt. into an inferior class of the 22 cwt.

If the metal of the English gun were so disposed as to preserve the present weight of the English shell, (51 lbs.) and this shell constructed on the French proportions,—the result is quite as obvious as in the foregoing. Such a shell must be inferior to the French in its content of powder, and also inferior to the

present 8-in. in force and accuracy; because its greater surface encounters more resistance from the air, while there would be no greater momentum to overcome it.

It is palpable, therefore, that no gain and positive loss would accrue to the English shell-power, as compared with the French, by modifying it after the French in any manner whatever. And the same applies to any modification of the French shell alone, after the system of the English.

But the 22 cent. shell-gun might be bored so as to admit a shell similar in its proportions to the English, which would be relatively superior to the English shell in the ratio that the French gun is heavier than the English gun, thus:

	Weight.	Content of powder.
English shell,	51 lbs.	$2\frac{1}{4}$ lbs.
French, modified,	$55\frac{3}{8}$ lbs.	$2\frac{3}{4}$ lbs.

Whether the advantage that would result from such an arrangement would be of importance, will depend on the application of the pieces. So long as they are made to perform a very subordinate part in the force of the broadside, it might be that no difference of moment would result.

But, if the number of shell-guns in the batteries were largely increased; or circumstances should bring them into operation where the peculiar powers of each kind would tell dis-

tinctly, particularly in deliberate fire, far or near, with shell-guns only; then there is no doubt that the occasion would make manifest the differences that have been indicated as due to the respective powers of one kind of shell or another.

In the solution of this problem, the navy of the United States is quite as much interested as the English, because our own 8-inch shell-gun and shell, differ in no material particular from the English.

This may be said with certainty,—at its own range, which includes most of the distances where action is admitted to be decisive, the French shell is clearly more powerful than the 8-inch.

At greater distances, the advantage of the 8-inch begins; and whether this can really be made effective at such ranges, may need the experience of actual conflict to determine the general opinion.

Having decided on the weight of shell which is deemed most suitable for a given calibre, its formation next becomes the subject of consideration.

When Paixhans proposed his plan of a naval shell-armament, he strongly insisted that preference was due to concentric shells; the practice of the principal maritime powers has since con-

formed thereto, and continues to do so, with the exception of our own service, which, for some years past has used shells decidedly excentric.

Since the general exposition of the shell system by Paixhans, in 1825, the effects of excentricity have been carefully examined by intelligent officers in many countries.

On scrutinizing the experiments made in England, France, Belgium, and the United States, their results and the opinions thence derived, there does not appear any sound reason for relinquishing the views most generally entertained with regard to concentric and excentric shells.

No one can doubt that the former being necessarily homogeneous, are subject to less irregularity of motion while passing through the air, than those which, by construction, are unequally dense.

The chief difficulty lies, however, in not being able to obtain shells in which the metal is of equal thickness, and therefore equally disposed about the centre of figure.

It may appear at first sight that a condition of this nature would be easy of attainment; but experience teaches another lesson, and one evidence thereof will be perceived in the fact, that in no country is the founder expected to attain the exact thickness at all parts, but has certain allowances made him for failure to do so; and if he does not exceed these the shells are received.

For instance,—by our Regulations, 8-in. shells should be 1.5 in. thick at all parts, except about the fuze hole,—but when shells are to be received for service, such as are not less than 1.45 in., and not more than 1.55 in. at any part, cannot be rejected,—that is, there may be a difference between opposite sides amounting to one-tenth of an inch, or one-fifteenth of the entire thickness. The effect of this is more injurious than might be supposed, because such differences are seldom due to mere inequalities of the interior surface, but commonly to the displacement of the core by which the cavity is formed, arising from an error of original adjustment, or from being disturbed subsequently, by the entrance of the fluid metal in casting. This is manifested by the excess and defect of opposite sides, and as a consequence, a lunular segment, having the diameter of the shell for its base, is abstracted from one side of the shell and added to the other.

The French Regulations allow a departure of 0.07 in. more or less from the prescribed thickness of the 8-in. shell, and in that respect seem to recognise a greater claim for indulgence to errors of the founder.

So long then as it is impracticable to avoid differences in the dimensions of the shells which render them excentric, there is no occasion to make an issue in regard to the preference that may be due to excentric or concentric shells.

For if the latter cannot be had, the practical question only concerns the best mode of dealing with the defect that must be encountered in all shells.

This will be best understood by stating the effects that want of homogeneity is admitted to exert on the trajectory; which statement may be properly preceded by a brief notice of the manner in which the current doctrine, concerning this property, has been initiated and finally established.

About 1737, Mr. Robins observed great irregularities in the flight of balls, which were not to be accounted for by the known action of either of the forces, recognised by theory and experiment to influence the formation of their trajectory:—the propelling power, gravitation, or the resistance of the atmosphere. To the latter he himself had first assigned its proper value, so far as the purposes of artillery were concerned, by proving conclusively that the resistance was much increased beyond the ratio due to the squares of the velocities, when the velocity was equal to that commonly imparted to cannon shot. This determined the true configuration of the trajectory; but Mr. Robins was not slow in perceiving that the direct resistance of the air could not explain the surprising deviations which occurred with every variety of ball, whether fired from the musket or the cannon.

Tracing the phenomenon experimentally through its several phases, he was at no loss to attribute the result to its exact cause; and pronounced these deflections from the assigned direction, to be due to the oblique action of the resisting medium on the surface of the ball, arising from its rotatory movement.

No suspicion, however, seems to have been entertained at that time, of the serious defects in homogeneity to which the material of cannon balls was liable; and Mr. Robins had no opportunity previous to his untimely decease, to prosecute his researches to their full conclusion, which would have undoubtedly led so able and critical an observer to realize the extent of this defect and its connection with the rotatory movement; a result only reached a century after he laid bare the true source of the inaccuracy in question.

Wherefore, he considered the sphere to be homogeneous, and that the rotation occurring about one of its axes was produced by the collision with some part of the bore in passing out.

In 1745, the labors of Mr. Robins were complimented by the attention of one of the ablest analysts in Europe, (Euler,) who translated his tracts and discussed the several topics therein presented. He differed from Mr. Robins, however, in the opinion that the rotatory movement of projectiles was the cause of their deviation, and thought on the contrary that it would have

the effect of counteracting such deviations as might arise from a want of sphericity.—(*M. Meyer*, 1745, 20.)

In 1771, the conclusions of Mr. Robins received remarkable verification from some practice for general purposes, executed at La Fere with a 24-pdr. The elevation was 25°, and a board was placed 32 feet from the muzzle to show the primitive direction of the shot; the results were:—

	Perforation in Board at 32 feet.	Range.	Deviations
1.	⅝ in. to the right.	3765 yds.	230 yds. to the left.
2.	½ in. to the left.	3848 "	38 " to the right.
3.	1 in. to the left.	4072 "	230 " to the right.

Anomalies so marked were only to be explained by the theory of rotatory movement, as expounded by Robins; but it does not seem that his solution, if known to the parties engaged, was admitted to be sufficient to account for the phenomenon so distinctly present.

In 1783, Lombard published his translation of Robins, with the annotations of Euler, and his own. He is said* to have agreed with Robins in regard to the cause of deviations, and explained those at La Fere by the hypothesis of the rotation produced by the final collision with the bore.

In 1789, Captain Luther, of the Saxon Artil-

* M. Meyer.

lery, indicated clearly the existence of excentricity in shells, and suggested the means of ascertaining its extent. He advised the classification of shells and bombs according to the angle formed by the axis through the fuze-hole and that through the centre of gravity,—so that the centre of gravity might be similarly placed in the bore of the gun, preferring a position in its axis for the purpose. By this device, he expected to obtain more uniform ranges, particularly in vertical fire. This is probably the first instance in which any consequence was attached to the excentricity of projectiles, if indeed it was known or considered at all. And curiously enough, Captain Luther thus touched directly the predominating cause of the rotatory movement, and its ill effects on the accuracy of cannon; but he seems to have been utterly unconscious that the excentricity produced any such movement.

In 1796 a comparison by eprouvette was instituted at La Fere, between the Champy and ordinary gunpowder, under the direction of M.M. Pelletier and Borda, and General Abeville. The irregular flight of the balls was thus noticed in their Report.

"The great deviation of the projectiles induced "the suspicion that it was not always due to "errors in pointing, and to their final collision "with the bore in leaving it. General Abeville "assured himself of the facts by the proofs in

"1771, and repeated them in 1796, while com-
"paring the angular and round powder. He
"placed a small piece of board 18 inches square
"and 6 inches thick parallel to the muzzle-face of
"the piece and about 20 feet distant—the axis
"of the bore being directed at the middle of the
"board, the perforation made in it determined
"the direction of the shot; from which its place
"of fall showed that it sometimes deviated as
"much as 8°,—and this could not be attributed
"to the wind, towards which the deviation often
"occurred. It was thought that it might be
"caused by the rotatory movement of the ball at
"leaving the gun, but it is difficult to believe
"that this alone could occasion the deviation."

"Whatever may be the cause of this lateral
"aberration, it can also act upwards or down-
"wards, produce much difference in the ranges,
"and occasion great errors in estimating the
"velocity of the balls by the distance at which
"they fall."—(*Aide Mem.*, 1801, p. 698.)

In 1797 the Treatise of Lombard on the move-
ment of projectiles, was published by his son.
Throughout this work I cannot say that the term
rotatory movement occurs once, and the force it
represents, appears to be entirely unnoticed.
This is singular, when it is considered that the
doctrine of Robins was well known to Lombard,
because he had translated and annotated the
work wherein it was so particularly set forth and
demonstrated, and is said to have approved the

views of Robins in opposition to Euler, who did not. Nor does Lombard even notice the increased ratio of resistance, which Robins also proved incontestably, but proceeds on the doctrine of its being proportional to the v^2 as enunciated by the illustrious Newton. Such an omission is the more remarkable, inasmuch as, the method of computing the initial velocity from the ranges by Lombard, must depend entirely upon a correct estimation of the effects of the resisting medium in retarding and varying the course of the ball.*

We can only understand this seeming inconsistency by supposing that Lombard admitted the theory, but attached no material value to it in practice. The observations made on the eprouvette results in 1796 (just cited) would no doubt have had their influence, but Lombard must have died before they were made known.

In 1798, the effects of excentricity on the accuracy were so far admitted, as to become the subject of scrutiny in Hanover. In the practice then executed, it appeared from firing a large number of howitzer shells, that the irregularities of those which were excentric, were double and treble those of the concentric.—(*Puixhans*, 191.)

In 1801, the *Aide Memoire* of that year published in detail the trials made at La Fere in 1796 with that part of the Report relating to the

* See Didion, who says that such errors were actually incurred.

deviation, which has been just cited, and it is commented on in the following terms:—

"How is it possible to know from these trials "that the balls deviated 8°? Nothing is said "of the part of the board which was struck, and "that alone is of consequence—for if the ball, "while in the gun (supposed to be a 12-pdr.), "strikes one side of the bore so as to graze the "opposite side in going out, it is clear from the "simplest idea of geometry (2 : 1 : : 240 : 120) "that it will pass 10° from the middle of the "board and therefore will not touch it. If to "this deflective force is added that which must "result from the gas operating obliquely on the "rear of the ball as it goes out, and in the same "sense, it will not be surprising that though "the piece were well pointed, the ball should "be carried very much out of the line of aim."* —(*Aide Memoire*, 1801, p. 698.)

In 1803, the French Military Committee observe in their report:—

"Reinforced howitzer shells have greater "ranges than those which are not reinforced." They do "not deviate more"—"a result for "which we are unable to account."

Paixhans (in 1849, however,) remarks on these phrases:—"In that lengthy paper these

* This would now appear to have been a very summary criticism, and was obviously too hasty, as the conclusions were by no means warranted by the premises.

"effects are referred to with surprise, and are "variously explained; but principally by the "collision with the bore, which is considered as "the chief cause; or rather, no principle is "distinctly assigned, nor any application of it "made. Nevertheless, one important thing was "then seen, (I know not if it were the first "time.) and Colonel Clement was of opinion "that irregularities in extent of range, should "be attributed to the same cause as the lateral "deviations."—(*Puixhans, Const. Mili.* p. 241.)

In 1808, Colonel Clement executed some experiments at Pavia, in the course of which he did not overlook this subject:—

"He fixed a strong oak plank at a short dis-"tance from an 8-pdr., its surface being slightly "inclined to the axis of the gun, and in such a "manner that the left side of the ball could not "fail to encounter the plank and to produce a "reflection to the right. To be certain of which, "a sheet of paper was placed beyond the plank "and these arrangements being made, the can-"non was fired three times; each time the ball, "after beginning to deviate a little to the right, "fell very considerably to the left."—(*Montgery*, 1828.

"In the work published this year, Colonel "Clement examines the *experiments* of 1803, and "says:"—The "extent and uniformity of range, "obtained with howitzer shells, is in proportion "to the distance of the centre of gravity from

"the centre of figure."—But he did not indi-
"cate what the respective positions, in the gun,
"of these centres should be."—(*Paixhans, Const. Mil.* 241.

In 1822, General Paixhans published his justly celebrated exposition of the *Nouvelle Arme;* in which he traced with a masterly hand the details of the system that in a few years was to work a total revolution in naval armament. In treating the question of excentricity and concentricity, he says, page 141:—

"The interior form of shells and bombs has
"undergone many variations, yet there is but
"one form which can be reasonably admitted,
"and that is exactly spheric and concentric with
"the exterior sphere, without reinforce;—the
"thickness everywhere equal and the centre of
"gravity in the centre of figure. Every princi-
"ple of theory, every well-executed experiment,
"and every conclusion based on enlightened
"examination, accord so perfectly on this point,
"that it would be superfluous to enter upon the
"proof."

In 1828, Captain Montgery, of the French Navy, in his *Regles de Pointage*, noticed the rotatory movement of projectiles as the cause of deviation; but considers it to arise from the collision of a concentric projectile with the bore, and abstains from all mention of excentricity as a partial or principal agent. He quotes the experiments of Colonel Clement at Pavia.

The important problem was now verging to its solution. It is difficult to know with any exactness by whom, when, or how it was initiated and prosecuted. The customary mystery which is purposely thrown about the discovery of some real or imaginary improvement in things of this nature, presents an obstacle to the information sought, and in this country the difficulty is increased by the exceeding scarcity of professional works on such subjects.

It is stated, however, on good authority,* that in 1833, certain officers of the Belgian Artillery were led to some slight experiments in consequence, it is said, of hints received from the Saxon service. What these were, we are not informed; but the whole question must have been so apparent from the premises to the conclusion, that it is only to be wondered at that any hint had been required for a long time antecedent to the period spoken of.

In 1837, Colonel Bormann submitted to the Belgian government a project in relation to the excentricity of projectiles and to the manner in which it might be made useful, at least so far as Shrapnel were concerned. A full investigation followed in 1838, at Brasschaet, on which occasion it would seem the whole question in regard to cause, effect and application must have received an intelligent and thorough treatment;

* Colonel Bormann.

as even the brief abstracts, made public by Colonel Bormann, suffice to explain the phenomena which, till that time, most certainly were not known by many, if known at all; of which we have confirmation in the statements of an eminent artillerist, (*Paixhans, Const. Militaire.*) He says that,—"In 1838, the cause of devia-
"tions and the means of avoiding them, were
"so little known among us, that M. Poisson,
"Examiner of Artillery, and a *savant* of the
"highest order, thus expresses himself in an
"elaborate memorandum:—'The equation of
"the movements of a projectile are so compli-
"cated, that it is impossible to obtain from them
"the approximate values of the unknown quan-
"tities, with sufficient simplicity to be of any
"utility.' He was obliged to confine himself to
"cases of very trifling deviation; while, practi-
"cally, and especially with shells, they are often
"very great. And with regard to the distance
"of the centre of gravity from the centre of
"figure, his theory did not assign an important
"influence; whilst in reality, this influence is
"decisive, as we shall see. In fine, he pro-
"duced nothing which materially advanced the
"theory, nor any thing that was practically
"useful."

The knowledge of these results having reached General Paixhans, he conducted a series of practice in order to satisfy himself in relation to the remarkable conclusions thus in course of develop-

ment, more especially with reference to heavy calibres. And thus he seems to have been led to an entire change of opinion in regard to the effects of excentricity, as may be seen by the following remarks, extracted from his *Constitution Militaire*:—

"There is in the excentricity of spherical "projectiles, a peculiarity which formerly was a "source of deviation and irregularity in range, "and which now may be made a means of accu- "racy, and of increasing or decreasing the range "at pleasure.

"The theory of deviation, difficult, arduous "and incomprehensible as it has been, even for "*Savants*, is thus by these experiments rendered "perfectly simple and certain."

In 1843, Major Wade made some experiments at Boston with Excentric shot and shells,—the result of which accorded with the views now generally entertained in respect to the consequences of excentricity on the flight of projectiles.

In 1848, when the practice for Range was begun at this place, the shells used in the Navy were purposely made very excentric; and as there seemed urgent reasons for examining the effects of this property more thoroughly than had been done when it was adopted, the practice for this purpose was included among the earliest operations of the New Battery. Concentric and Excentric shells, in series of ten at each degree

of elevation, were fired, and the results laid before Commodore Warrington at the earliest date. They were included in the first of my Reports printed by his order.

In 1850, 1851, and 1852, at the request of Sir Howard Douglas, a course of firing was executed at Portsmouth and Shoeburyness in order to verify the statements in regard to excentricity, which must at the same time have become pretty generally known from the practice in Belgium and elsewhere.

Excentric projectiles were fired from 32-pdrs. and 8-in. shell-guns, 68-pdrs. and 10-in. guns,* and the results were in all respects confirmatory of those obtained in other countries. In view of which Sir Howard Douglas expresses his continued preference for the concentric and homogeneous projectile, (168.)

This then is the view that presents itself of the devious and uncertain manner in which this interesting question forced its way to the light, so far as I have been able to pursue it by means of the scanty materials at my disposal. Its treatment through so long a lapse of time, may excite reasonable surprise when the importance now attached to it, and the seeming difficulty of avoiding the final conclusion, are considered. Sometimes contested, at other times neglected,

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* A gun of this calibre, weighing 116 cwt. burst at the 54th round, charge 16 lbs.—elevation, 32°—Range 5860 yards.

and never, until recently, fully comprehended or appreciated in its proper connection; yet of itself was it the principal deteriorating influence that rendered artillery practice the merest accident, and set at defiance all attempts to raise gunnery beyond the repute of sheer handicraft. Not a shot left the cannon that did not offer some instance of strange irregularity, equally puzzling to the operator and prejudicial to the character of his work.

All this may be attributed either to ignorance of the doctrines of Mr. Robins, or to disbelief on the part of those who were cognizant that it embodied an operative principle.

We see that General Paixhans bears witness to the little knowledge generally professed in regard to the subject, so late as 1838, and from his position, and high reputation as an artillerist, we could have no better authority.

The doctrine commonly received (and confirmed by experiment) in relation to excentricity, and its consequences upon the trajectory of cannon balls, may be briefly summed, thus:—

When the centre of gravity does not coincide with the centre of the sphere, a revolving motion is created around the centre of gravity, the direction of which depends on the position that the centre of gravity has to the centre of the sphere.

This rotation, during the flight of the projectile, occasions a greater resistance on one side of the hemisphere which is in front, than on the

other; because on the former the progressive and rotatory movement concur, and on the other they are in opposition.

Hence the projectile is made to incline from its direct course by the greater pressure which it sustains on one side; and the aberration thus produced will be in the prolongation of the plane passing through the axis of the bore and centre of gravity, and will occur on the same side of the trajectory as the centre of gravity occupies with respect to the axis of bore.

So that, if the centre of gravity be in the vertical plane, the deflection from the normal trajectory will be vertical and upwards, or downwards, accordingly as the centre of gravity is in the upper or lower hemisphere. If above, the range will be increased; if below, decreased, by the very conditions of the case and without lateral deviation.

If the centre of gravity lie in the horizontal plane, the deflection will be entirely lateral, and right or left as the centre of gravity may lie.

If the centre of gravity occupy some position between the vertical and horizontal planes, as it commonly does, then the aberration will be partly vertical and partly lateral.

It does not appear that the location of the centre of gravity in the anterior or posterior hemisphere, materially affects its operation, if the angle with the vertical axis be similar; except that there is a slight increase of range when

the centre of gravity is in the posterior hemisphere and in the axis of the bore.

In general, the effect of the rotation on the trajectory, may be briefly represented thus: Departing with any given displacement of the centre of gravity upwards, and adhering to the vertical axis, the range will be augmented to the greatest extent that the excentricity is capable of, and without effect laterally. Turning the ball in the bore, it will be found that the range will decrease as the centre of gravity is moved downward, whether in one plane or another, until it reaches the lowest part of the sphere, when the range will be least,—the lateral deviation will increase with the change of position from the plane of projection, until it reaches the axis of that plane, when it attains the maximum.

When the centre of gravity lies in the axis of the bore, its effect is trifling, and the trajectory nearly corresponds with that of the concentric projectile.

The extent of the divergence from the normal trajectory will be controlled by the position of the centre of gravity,—by its distance from the centre of form, and by the celerity of rotation;—the quantity of unequal resistance on the surface of the ball depending on all of these.

The facts already cited in regard to the inexactness of dimensions, will convey a fair idea of the excentricity to which the best made shells are liable; and its consequences upon the equili-

bration may be very readily seen by floating a number of shells, taken promiscuously from a lot intended for service. For this purpose, the shell must be closed perfectly at the fuze-hole, and placed in mercury, when it will at once commence an oscillating movement, and finally rest with the axis through the centre of gravity in a vertical position, the pole of which is determined by suspending a small disc with its lower surface horizontal and tangential to the surface of the shell; the disc being coated with paint, allow it to come in contact with the culminating point of the shell, and to make a mark which will indicate the pole of the axis in question, sufficiently near for practical purposes.

In a number of shells it will be found that this spot will occupy every variety of position on the surface of the sphere. The extent of the excentric force may be made to appear by the character of the vibrations produced when the floating shell is put in motion; or if desirable, it may be measured with some precision.

The variations which the operator will experience in the position of the centre of gravity, with reference to a fixed point, the fuze-hole for instance, and in the amount of the excentric force, will enable him to appreciate the irregular effects that must thence be produced upon the flight of the shell, if this cause be allowed to act uncontrolled. As the fuze must have one position when the shell is in the gun, that of the

centre of gravity will be constantly variable,—up or down, right or left, as may be, and its consequences to the accuracy of fire, will correspond thereto; sometimes increasing the range, or decreasing it,—at other times producing lateral deviation,—but generally affecting both range and direction.

If it were possible to place the shell, thus made, in the gun so that its centre of gravity should have one fixed position, these erratic features of accidental excentricity might be remedied.

But it is not possible; because the fuze of the shell requires this condition indispensably, and for its proper ignition must be placed in the upper quarter of the outer hemisphere. This affords the disturbing element fair opportunity for a full exercise of its powers, and must necessarily operate most prejudicially on the flight of the shells.

Thus we conclude that the effect of excentricity depends:—

1st. On the distance of the centre of gravity from the centre of sphere.

2d. On its position.

3d. On the celerity of the direct movement.

Now these being all variable in extent and in combination, must produce a corresponding effect on the results; and in a very extensive series of practice, it could hardly be expected that this obtrusive and troublesome element

could furnish an instance of approach to similarity in the combined action of its components.

Its ill effects are neutralized to some extent by:—

1st. Refusing all projectiles that vary unusually from the ordinary amount of excentricity.

2d. Controlling the position uniformly.

3d. Carefully avoiding causes likely to vary the velocity.

There is but one of these conditions, however, that can be eliminated entirely, viz: variation in position. The other two will continue to exert more or less of their mischievous influence, because they cannot be removed entirely, but only limited in their extent; within which, differences will still continue to occur.

It is, therefore, unreasonable to assert that any benefit to precision can be derived from this property as it exists, so far as uniformity of movement is concerned; because we see that its unequal intensity must necessarily be productive of irregularity in flight, and this is confirmed by experience as well as by theory. For we know that if a projectile were only acted upon by the propelling force, by gravity and by the resistance of the air, its trajectory would unquestionably lie in a given plane and its configuration be uniform. But irregularities occur in the best practice, which are not accounted for by variations in elevation, or direc-

tion, or force of projection, and must be due to some other cause,—*that*, all experiment indicates to be the oblique action of the resisting medium, produced by variable excentricity.

Again, the effect of the excentricity will also be consistent with itself,—that is, as the differences between the excentric and normal trajectories increase, so will increase the differences between the individual excentric trajectories,—in other words, the inaccuracy of fire.

As no advantage, but evident loss of precision must then be incurred by the presence of this inconstant force, so far as the effect of its own movement is operative, it remains to ascertain whether any compensation is derived from the superior directness of its trajectory.

As the extent of the excentric trajectory can be made greater than the normal trajectory,—other conditions being alike,—it is naturally inferable that this arises from less inflection of the curve,—and we know that such would conduce to accuracy.

But we also know that excentric projectiles are indued with no greater power for range or penetration than the concentric. The mean initial velocities are alike,—their weights are alike,—the surfaces presented by them* to the resisting medium are alike; the assigned angle of flight alike. Wherefore, the greater extent of the range can only be owing to the well recognised effect of the excentric force, by which

the trajectory is incurvated upwards in consequence of the oblique resistance.

If so, then the claim of advantage due to greater directness of the trajectory is disposed of summarily, because it is not rendered more direct but is absolutely more incurvated.

Moreover, the augmented ranges thus produced, are obtained partly by elevation of the gun, partly by the subsequent elevation of the trajectory—and it hardly seems judicious to make use of two agencies to effect an end when one of them—and that the more reliable and controllable—will answer the purpose, unless indeed it were impossible to elevate the gun as much as might be required.

It will be observed that it is not designed to treat this question in a purely speculative manner, by discussing whether shells uniformly excentric are to be preferred to those which are perfectly concentric; but to regard the practical issue, which is, that no care of fabrication can produce either one or the other of these projectiles. All are more or less deficient in homogeneity, and the evil is, that they are unequally so; wherefore, as the ill effects of this fault increase with the extent of the excentricity, it seems advisable to have as little excentricity as possible.

The limit is determined, so far as shells are concerned, by the ability of the founder to approximate exactness in the figure, and concen-

tricity of the sphere and its cavity, with equal density of the metal; and the extent to which it is permitted to depart from the exact dimensions assigned, indicates what has been found practicable with regard to accuracy of dimensions.

The excentricity then, being reduced to its minimum, there remains to consider the practicability of controlling its direction; otherwise, as already shown, it is liable when existing accidentally, to act in every sense and frequently in opposite senses, from which must follow the full extent of anomaly that the excentricity is capable of.

But it is not practicable to place the *accidental* centre of gravity uniformly in the gun—for as its relative position with the fuze is variable, the consequence would be that the latter would often be turned down, or towards the charge, and thus lessen the chance of ignition or incur the risk of bursting the shell in the gun.

It only remains therefore to counterpoise the accidental excentricity (arising from unequal thickness of the shell or unequal density) by reinforcing the metal at some part so as to determine the centre of gravity on that side of the centre of form, using, however, no more metal than is sufficient for the purpose; to which may be applied the term *compensating mass*, to distinguish it from the accidental excentricity, and that used on the supposition that it is beneficial.

The question that will concern those interested, will be to ascertain which alternative is preferable.

By means of the compensating mass, is had the least possible excentricity that is compatible with uniformity of operation in direction; the lateral deviations may be nearly annulled, and those of extent may be reduced to a minimum, by having the irregularities of like sign. With the accidental excentricity, the positive departure of any one ball from the normal trajectory is less; but the disagreement of a number of trajectories among themselves is greater, because they may occur on different sides of the normal trajectory.

Supposing then that the centre of gravity, as determined by a compensating mass, is to be controlled; it will be admitted without question that it should lie in the plane of projection, in order to avoid lateral aberrations. But where in this plane?

If above, the range is increased; if below, it is decreased; though, it is claimed by some, with greater regularity in the flight of the projectile.

But when the centre of gravity is to be inclined with respect to the vertical plane, then the certainty of retaining it in the plane of projection is assuredly lost. For the sabot previously fixes the one, but the loader fixes the other at the time, and under the most unfavorable circumstances.

In experimental practice with well trained men, more time is needed for this purpose than for any other in preparing the gun; and even when the shell is entered properly, it is observed that it turns in being pushed to its place, and a ladle is commonly used to correct the error. In the haste and excitement of action is it possible to accomplish any such thing? If not, then is the range not only lessened, but the lateral deflections are augmented to the full measure of the excentric force. When the shell is strapped to its sabot, so as to have the centre of gravity in the axis of the bore, then there is no difficulty whatever in regard to its position—for it is possible to have but one, whether the firing be slow or rapid.

The foregoing remarks may be illustrated by the following extracts from the notes of practice.

In arranging the armament for the new Screw Frigates, it became necessary to review each of its elements in detail.

The shells first cast for the guns designed to constitute their batteries, were taken from a number that were intended to be of equal thicknesses. Notwithstanding great care was used in selecting them, more than would be possible for general service, the practice with them was unsatisfactory, and the irregularities in flight greater than might have been reasonably anticipated.

Shells were then cast with an interior seg-

mented mass, the dimensions of which were ascertained to be just sufficient to overcome the usual defect in concentricity, and to determine the weightiest part of the shell in one direction.

Its amount was about $\frac{1}{64}^{th}$ of the empty concentric shell.

To ascertain its effects, a series of practice was executed very carefully at a screen, distant 1300 yards from the Battery, the shells being placed with the centre of gravity in several positions: first, inward—then in the vertical plane at 90° upward and downward, and at 45° inward.*

The mode of proceeding conformed to that customary at the Experimental Battery, as the following sample shows:

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* To complete this, series were to have been fired at 45° upward and outward, &c.; but the demands of other duty prevented it.

NEW SHELL-GUN.

Shells filled with rice, and strapped to the sabot so that the heavy point was in the axis of bore, and nearest the charge.

Screen, 20 feet high and 40 feet long, at 1300 yards.

Cloudy and perfectly calm—water smooth.

Bore of gun above water, 7ft.10. Initial velocity of powder, 1571.

Charge 10 *lbs.*

	Graze on the water.				Time of Flight.	Perforation on Screen.		
	1st.	2nd.	3rd.	4th.		Above water.	Right.	Left.
No.	Yds.	Yds.	Yds	Yds.	"	Feet.	Feet.	Feet.
1	1255	1701	1 22	2056	4.3	10.4	12.9	.....
2	1363	1723	1879	2056	4.6	16.14	Centre.	
3	1331	1788	1979	2127	4.4	8.3	.....	19.25
4	1327	1736	1934	2117	4.3	7.74	.....	14.50
5	1344	1876	2132	2366	4.5	12 58	5.25	.....
6	1274	1655	1820	1961	4.2	7.56	0.25	.....
7	1369	1757	1972	2269	4.5	3.58	4.70	.....
8	1307	1766	1964	2144	4.5	3.4	8.80	.....
9	1361	1815	1969	2140	4.6	17.54	.....	19.30
10	1342	1765	1930	2089	4.5	Miss'd.		.....
	1325	1758	1952	2133	4.44			

As the screen was maintained constantly at one distance, 1300 yards, the elevation required to reach it, necessarily varied with the position of the compensating mass. For convenience in comparison the ranges are reduced by interpolation to a common angle.

Centre of Gravity in Vertical Plane.		Yards.
Culminating point,	90° up.	1415
Opposite,	90° down.	1264
In plane of projection,	inwards.	1329
	45° up and in.	1360

The anomalies are no greater than are unavoidable in cannon practice, and seem sufficiently consistent to warrant the conclusions that have been deduced in the previous remarks.

The greatest range occurred when the centre of gravity was directly above the centre of figure, and the least when directly below it, the difference being about 150 yards. The normal trajectory, or that of a concentric shell, was very fairly represented when the centre of gravity lay in the axis of the bore, and its extent was about the mean of the two extremes; being 75 yards less than the range produced by the maximum effort of the excentric force, equal in this case to about one-quarter of a degree of the arc.

The differences between the normal and eccentric trajectories will increase and decrease with the range, but not proportionally with its extent —on the contrary, the increase of this difference is in a much higher ratio.

Hence, as the scope of fire is extended, a much greater elevation of the gun would be needed in order to make the concentric shell reach as far as the excentric. But the inaccuracies of the latter would increase also. Wherefore, it is clearly more preferable to adhere to

the elevation of the bore to produce range, than to combine with it the uncertain effects of the excentric force. And it is believed no difficulty will be found to interpose practically, because with broadside guns, the port need not be inconveniently large that will permit them all the elevation that is required for the full scope of their effective fire. The pivot guns are unrestricted by any port, and are capable of greater elevations than can ever be useful.

The range is increased very slightly when the centre of gravity, being in the axis of bore, is nearest the charge of the gun.

The results of this practice, and of other calibres, do not seem to establish that the dispersions of the several trajectories of a series, are less in one position of the centre of gravity than another; it is true the differences are not so great in some cases as in others, but they are within the limits commonly observed, and do not warrant any decided opinion; nor would they be material even if confirmed by subsequent experiment. Colonel Bormann is of opinion that the variations in the trajectories of a number of balls, are less when the centre of gravity is directly below the centre of form. It may be so, but it will require a more precise and extended practice, and a higher development of the excentric force than that obtained by the compensating mass, to put the question beyond doubt.

The preceding remarks have reference especially to shells, but it need hardly be observed that they are also applicable to solid balls.

In these, the displacement of the centre of gravity can only be owing to unequal density of the iron; while in shells it is chiefly due to the unequal quantities disposed about the centre of form, by variations in the thickness of the shell.

Many excellent authorities have admitted the operation attributed to excentricity, but assert that it is inadequate to any practical effect upon the direction of shot. There is reason for a different opinion, as will appear from the following practice, the object of which was to indicate the importance of all possible care in service.

Two series of 32-pdr. shot were fired. One set was taken promiscuously from a heap inspected for service, and another set selected carefully for experimental practice. In the one, the extreme variations of size amounted to six-hundredths of an inch in the diameters, and those of weight corresponded thereto. In the other set the extreme variations in diameter were limited to two-hundredths of an inch, and the weights were uniform. The service shot were rolled into the gun and a gromet wad placed over them. The experimental shot were saboted so as to have the axis, through the centres of figure and gravity, in one position:—

EXPERIMENTAL BATTERY, SEPT. 18, 1850.

U. S. Naval 32-pdr. of 42 cwt.—Charge 5 lbs.

ELEVATION 3°.

First 10 rounds, perfectly calm—second, light air W. S. W., slight ripple.

Selected Shot—Gauges = 6 in. 24 × 6 in. 26.			Service Shot—Gauges = 6 in. 22 × 6 in. 26.		
No. of Round.	Wgt. of Shot. lbs.	1st grass. Yds.	No of Round.	Wgt. of Shot.	1st grass. Yds.
3	32.43	1141	19	32.78	1095
7	.44	1157 (−16)	15	.90	1109 (−14)
18	.47	1181 (−24)	10	33.00	1139 (−30)
1	.43	1185 (−4)	2	32.43	1143 (−4)
9	.45	1198 (−13)	8	.80	1153 (−10)
20	.47	1203 (−5)	6	.64	1160 (−7)
12	.46	1206 (−3)	13	.84	1198 (−38)
5	.44	1215 (−9)	4	.79	1221 (−23)
14	.45	1228 (−13)	17	.53	1244 (−23)
16	.44	1234 (−6)	11	.77	1261 (−17)
	32.45	1195 (−39)		32.75	1172 (−133)

Mean Range	= 1195	=	1172
Sum of Differences	= 93	=	166
Mean of do.	= 10.3	=	18.4
Mean time of Flight	= 3″.9	=	3″.9

EXPERIMENTAL BATTERY, SEPT. 24, 1850.

U. S. Naval 32-pdr. of 42 cwt.—Charge 5 lbs.

ELEVATION 4°.

Very light variable airs from W. S. W.—Water smooth.

Selected Shot—Saboted—Gauges = 6 in. 24 × 6 in. 26.			Service Shot—Gauges = 6 in. 22 × 6 in. 28.		
No. of Round.	Wgt. of Shot. lbs.	1st grase. Yds.	No. of Round.	Wgt. of Shot. lbs.	1st grase Yds.
3	32.43	1352	11	32.71	1338
9	.42	1358 − 6	10	.61	1379 − 41
16	.43	1377 − 19	4	.66	1387 − 8
7	.42	1433 − 56	2	.62	1400 − 13
1	.43	1442 − 9	17	.54	1419 − 19
18	.43	1446 − 4	13	.57	1426 − 7
12	.43	1454 − 8	19	.34	1455 − 29
20	.43	1455 − 1	8	.75	1510 − 55
14	.43	1460 − 5	6	.11	1513 − 3
5	.42	1495 − 35	15	.36	1608 − 95
	32.43	1427 − 143		32.53	1444 − 270

Mean Range	= 1427	=	1444
Sum of Differences	= 143	=	270
Mean of do.	= 15.9	=	30
Mean time of Flight	= 4 sec. .81	=	4 sec. .98

The *mean* ranges do not differ considerably,—for all practical purposes they are equal,—but the irregularities of the service firing are reduced one-half by the precautions used in experimental practice, which are by no means difficult of ordinary application.—Are the advantages worth the trouble in service?

It is true that other causes may and do affect the uniformity of flight in projectiles, though in an inferior degree to the excentricity.

Thus, in consequence of the difference between the diameters of the bore and the shot, the latter does not move directly along the bore, but is reflected from one side to the other when driven out by the charge. Its final direction, therefore, on leaving the gun, will depend on that which it receives by the last collision of the bore. If this occur on the upper side of the bore, the trajectory will be less elevated than the inclination of the bore,—if on the lower side, the angle of flight will be greater.

This cause will generally be found in the same sense, but not always,—in which case the anomalies in range, due thereto, will be greater,—for their extreme differences will then be constituted by the sum and not by the difference of the individual deviations.

In the results of practice at Gavre, (1830 to 1838,) particular care was taken to note the error due to collision with the bore, as one of the principal objects of the practice was to de-

duce the initial velocities from the range by Lombard's method, of which this was an indispensable datum.

GENERAL CONCLUSIONS.

1st. It is desirable that a shell should contain the greatest possible quantity of powder; but in the proportion that this capacity is extended, the accuracy and penetrating force of the shell is lessened.

2nd. These conflicting conditions must be harmonised according to the part which the shell-guns are designed to fulfil,—whether they are to be the principal or auxiliary power of the Battery.

3d. Excentricity is capable of giving to the projectile a higher than the normal trajectory, the assigned elevation being alike. But its unequal intensity produces important variations in the several trajectories of a series of rounds, even when the action of the excentric force is uniform in direction; therefore, the accuracy is proportionally affected; while equal range with greater accuracy is attainable by means of a concentric projectile, and an inconsiderably greater elevation of the given trajectory.

4th. There is also an assured inability to control the direction of the excentric action, when

so used as to augment the range, arising from difficulties in loading the gun; from hence occur increased lateral aberrations, and also greater variations in range.

5th. Concentricity, therefore, is desirable for all shells.

6th. The unavoidable imperfections of fabrication render this unattainable,—and it is only practicable within certain limits,—which, however, are still capable, if left to act uncontrolled, of exerting very injurious influences on the accuracy of fire.

7th. This suggests the use of a compensating mass, by which the accidental and irregular excentricity can be counterpoised wherever it may be in the shell, and the centre of gravity determined in a given position with regard to the axis of the shell, that is to coincide with the axis of the bore.

8th. The excentricity thus produced should never be greater than is absolutely indispensable to counteract that which is entailed by the defects in the process of making the shells. And for convenience in practice, as well as for other reasons, it is preferable to place the shell so that its axis passing through the centre of gravity and centre of form, should be coincident with the axis of bore; or rather parallel to it, inasmuch as the centre of the shell is lower than the axis of bore by the amount of windage.

THE RIFLE.

The rotatory movement then is the cause of the great irregularity in the course of projectiles, —to which there is but a single exception, that is, when the axis of rotation coincides, or nearly so, with the line of flight. In this case the several parts of the foremost hemisphere are presented successively to the resisting medium, and the irregularities of density in the mass are thus compensated.

But the difficulty exists in the seeming impossibility of establishing this motion with a projectile fired from a smooth-bored gun; for the axis about which the ball is to revolve, lies in the direction of the impulse, and is parallel to the surface by means of which the rotation is to be engendered. The common and well known solution of this problem is obtained by cutting spiral channels into the surface of the bore, forming in effect the female threads of a screw, the number, pitch and depth of which, are determined variously.

When the material of the ball is sufficiently plastic, there is no difficulty in forcing portions of its surface to enter into the grooves, so that when moved by the gasses of the charge, the ball is compelled to take the direction of the spiral and thus the desired circumvolution is attained during the flight of the projectile.

Rifles have been in use for a long time, and according to M. Meyer, one is extant, made in 1600. Still we must not confound the discovery with the general use of the weapon.

It is known, however, that this means of obviating the effects of rotatory movement, was applied long before the nature of the difficulty which it remedied was itself dreamed of or apprehended.

Mr. Robins established at once its existence and the true principle of the rifle. The surprising neglect which seemed to attend his labors, was in nothing more conspicuous than in the history of this weapon. The rotation of the ball upon a given axis, and the invariable presentation to the resistance of the atmosphere of the surface originally placed in that direction, would seem to indicate beyond the possibility of misconception, the advantage that was to be obtained from it. And yet it is only in our own time that the round ball has given way, in the rifle, to the conical or elongated shot. The great merit of the arm was consequently of little account, because the resistance experienced by the round ball from the atmosphere, was nearly the same, whether fired from one piece or another; while with like charges, there was a certain decrease of initial velocity, from the friction in the rifle. But with the conical or even elongated shot, the surface of the transverse section was decreased, while the weight remained,—therefore there was

less resistance to overcome with the same power; the trajectory less inflected at equal distances, and the capacity for greater ranges obtained.

Now that the teachings of the master are understood and applied, it seems incredible that such a blunder should so long have been tolerated; while the cause of its correction is in keeping with the whole proceeding.

The use of the rifle had been well understood in this country and abroad for a long while; but the time and skill required in loading it properly, and even then not rapidly, had interfered with its introduction among troops of the line, and it was restricted to the hardy hunters of all countries who found their subsistence among the forests and the mountains, and whose natural intelligences were sharpened to the greatest degree by daily exercise and necessity.

In 1829, Delvigne undertook to remove the obstacles to its more general use, and to bring the manipulation of the arm within the capacity of the *personel* of the line.

He used a round ball, which was to lodge upon the edge of a chamber, and then be flattened by the rammer, so that the equatorial section should be extended and compelled, as the ball issues from its seat, to enter portions of its surface into the grooves,—thus receiving the motion due to their inclination. Some difficulties in the process were noticed, to remedy which, Thourenin proposed to use a small stem

projecting from the breech-plug into the bore, around which the powder was to fall, and upon its end the ball should rest, as on an anvil, so as to be flattened out by the rammer as before. But the presentation of only part of the lower hemisphere of the ball to the charge was unfavorable to its full action. Wherefore Delvigne proposed to make the base of the ball flat and to develop the metal upon it in the form of a cone,—hence the conical or elongated shot.

In this indirect manner and by the compulsory process of a mere detail, was the rifle musket brought to perform in Europe the part which had been so clearly explained almost a century before by Mr. Robins, and illustrated by his oblong ball.

The conclusion thus reached, seemed to proceed as directly from the primary conditions of the case, as the plainest demonstration of Euclid. And now that whole armies are to wield the rifled musket with its conical shot, and the tremendous powers of the weapon have been made manifest on the battle-field, one is surprised at the time which was permitted to elapse ere the demonstrations of the able experimenter were understood, upon whose mind the importance of the rifle was so deeply graven, as to evoke the following memorable expressions of his convictions:—

"*I shall therefore close this paper with predicting*
"*that whatever States shall thoroughly comprehend*

"*the nature and advantages of rifled barrel pieces,*
"*and, having facilitated and completed their con-*
"*struction, shall introduce into their armies their*
"*general use, with a dexterity in the management*
"*of them; they will by this means acquire a supe-*
"*riority, which will almost equal any thing that*
"*has been done at any time by the particular excel-*
"*lence of any one kind of arms; and will perhaps*
"*fall but little short of the wonderful effects which*
"*histories relate to have been formerly produced by*
"*the first inventors of fire arms.*"

(Read before the Royal Society, 1746.)

How fully the prediction has been fulfilled in the fierce conflicts in the Crimea, is yet fresh in the common remembrance. And our own War Department recognises the conclusiveness of the prevailing opinion, in the following sentences of the Annual Report to the President:—

"Although our experiments have been con-
"fined to our service rifle, and are yet in-
"complete, they confirm the great superiority
"claimed for this invention abroad. They show
"that the new weapon, while it can be handled
"as readily as the ordinary musket, is at least
"equally effective at three times the distance,
"and the foreign experiments indicate a still
"greater superiority of the new arms. These
"results render it almost certain that smooth-
"bored arms will be superseded as a military
"weapon." * * "In anticipation of an in-

"creased, if not exclusive use of rifle arms by "the regular army,"—&c., &c.

(*Report of Secretary of War, Dec.* 4, 1854.)

But it would be doing less than justice to our own country to omit noticing the prior use of the conical ball in the United States, by some of our riflemen, who intuitively perceived the real result, and approached it directly and intelligently.

The sample in my possession is said to date from 1827—it is 0.67 inch in diameter at the butt, 1.27 inch long, and weighs 1¾ ounces.*

So far, the rifled small arm alone has been referred to; but it is very plain that the principle of its construction has application to all sizes of projectiles, and would therefore be

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* In the Report of a Committee of Officers sent by the English Board of Ordnance to the United States "for the purpose of "inspecting the different gun factories in that country, and pur- "chasing such machinery and models as may be necessary for the "proposed gun factory at Enfield,"—it is stated that—"The fine "rifles used in the United States very much surpass in accu- "racy the Minié and other rifle muskets of Europe,"—&c., &c.

One of the Board witnessed a rifle shooting match at Fort Plain, in which one of the marksmen made "a string (the sum "of distances from the centre of 20 shots which measured 32½ "inches," (averaging 1⅝.) distance 220 yards. "This was "considered a good 'string,' as the weather was windy and "unfavorable."

The same officer was shown a "string" of 10 shots fired at 220 yards, measuring only 7½ inches (averaging 0m.775.) "This is supposed to be the best string on record, and was "made with a telescopic sight."—*Report to House of Commons, July* 10, 1855.

used for the heaviest ordnance as well as for the smallest. Contemporaneous attempts so to adapt it have not been wanting; but they are so isolated in point of time and connection, as to be open to question even more than those which mark the course of proceeding with the musket.

The first persevering and rational efforts to apply the rifle principle to cannon, were initiated some twenty years since,—and the names of Wahrendorff, Cavalli, Lancaster and others, are identified with ingenious contrivances to overcome the difficulties, of no ordinary character, that beset the question.

The guns of Cavalli and Wahrendorff receive the charge at the breech, which mode of loading a gun has always been considered exceedingly objectionable; and so far as the scanty information goes that has reached here, it does not appear that these gentlemen can be said to have been successful in removing the common scruples that are entertained to all arrangements touching the solidity of cannon about the charge.

The gun of Mr. Lancaster has, however, attained a celebrity which will not permit its being passed by briefly, though the last reports that came to us, affirm its entire failure in service.

In the form best known and hitherto used, (though not restricted to any one calibre,) this

gun weighs 95$^{cwt.}$ (10640 lbs.) The peculiarity of its bore may be explained by supposing it to be perforated cylindrically to a diameter of 8 inches, in which two spiral channels or grooves are cut, commencing in the vertical axis and proceeding along the bore to the bottom, with a turn of one-fourth the circle, so that they terminate at the bottom in the horizontal axis —the helix is not regular but inclines very gradually from the position of the shot, and increases as it advances to the muzzle, being what is termed "an increasing twist."

Now if the rectangular corners of the grooves be chamfered away gradually at the muzzle, and the metal be removed with a regular diminution, until the horizontal axis is attained where the diameter of the bore is to remain as it originally was, the transverse section of the bore will be made elliptical; and by continuing the chamfer of the corners along the whole length of the groove, the bore will acquire an elliptical helix, the major and minor axis of which will have the fourth of an entire revolution, increasing gradually from the bottom of the bore to the muzzle.

Supposing that a projectile were so made that its transverse section was elliptical and accorded exactly with the ellipse of the bore, then it is evident that when inserted in the bore, and pushed to the bottom, its greater and lesser axis must continue to conform to those of the

bore respectively, and therefore will be compelled to perform one-fourth of a revolution in passing to the place where it is to rest. So likewise, when propelled by the discharge, it can only escape from the gun by following the helix of the bore, and in this way receives a rifle as well as a direct motion.

Thus the transition from the common channelled groove to an elliptically bored gun, seems to be readily suggested, and yet it has only been resorted to quite recently.

It is also certain that Mr. Lancaster's name has been universally connected with the idea. A writer in the *N. Y. Herald*, (Mr. A. Jones,) claims, however, priority of invention, and corroborates his claim by referring to certain propositions made by him to the U. S. government in 1842. If this be correct, and Mr. Lancaster cannot go beyond that year, there can be no doubt that the original design belongs to Mr. Jones.

But it is also true that Mr. Jones could never have established the merits of his contrivance, or made it useful with the form of ball which he originally devised, and has not yet proposed to modify. This was spheroidal, and would practically be of no more effect than a round ball fired from a rifle, inasmuch as the uniform presentation of one surface by the rotatory motion around the line of flight, was not connected with additional weight of ball which alone it

permitted,—therefore, the increased momentum was lost that would have given more capacity to overcome the atmospheric resistance, and produced greater accuracy and greater range, by means of a less incurvated trajectory.

Mr. Lancaster fell into no such error, but keeping the very object of the rifled motion directly in view, made use of an elongated ball, elliptical in its transverse section, and nearly conical in the plane of projection. Indeed, it would be difficult to understand how he could have done otherwise with the lights of the time before him.

The information that has transpired with regard to this gun, is too limited and imperfect to furnish the data from which alone it is possible to reason correctly to a conclusion.

Still it may be, that with such as we have, some idea can be conveyed of the expectations that are to be properly entertained in regard to the gun.

The value of any piece of ordnance will depend on the accuracy, power, and general efficiency which it is properly capable of exercising.

1st. Accuracy is derivable from the uniformity of axial motion, inevitably incidental to all military projectiles of whatever shape, and from the configuration of the trajectory.

The data upon which any admissible process of reasoning could be based, with regard to the

axial motion of the Lancaster projectile, are entirely wanting in the precision absolutely indispensable to the purpose—hence the propriety of postponing all remarks on that part of the subject.

In regard to the configuration of the trajectory, it may be said that the transverse section of the elongated ball is nearly equal to that of the round ball; therefore, equal atmospheric resistance is to be overcome by both balls—but it is overcome more easily by the elongated ball, because of the more favorable development of its anterior surface and of its greater weight, ($\frac{1}{3}$ or $\frac{1}{5}$ more than that of the round ball.)

If then the velocities at leaving the gun were alike for both balls, the elongated ball, as it proceeds in its course, must lose less speed by reason of the opposition it encounters—therefore it will retain a higher velocity than the round ball.

But the initial velocity of the Lancaster shot, or shell, is less than that of the round ball, because the charge is less proportionally. It would be less, even if the charges were alike, because of the greater weight to be moved.

Hence it follows that, in the first part of the trajectory, the Lancaster moves with much less celerity than the round shot of like calibre—therefore in equal times it does not attain equal distance; for the power of gravity is acting on both projectiles, so that the Lancaster intersects

the common plane sooner than the round, and its range thereby determined, is obviously less than that of the round shot. To make the range of the Lancaster equal, it must have a more elevated trajectory, so that the time required to attain the given point may be equal to that required to gravitate to the required plane. Hence its trajectory is more inflected than that of the round shot, and a corresponding diminution of accuracy ensues.

But the elongated ball experiences less diminution of speed than the round ball, and therefore as the range increases the disadvantage of the elongated in regard to the curve of its trajectory is lessened.

Next, the rate of the elongated ball becomes positively greater than that of the round ball, and at last sufficiently so to make the time of flight equal. After this, the elongated ball exceeds the round shot in range, and continues to do so in an accelerated ratio.

Now so far as the relative accuracy of the two projectiles depends on the directness of the trajectory, the round ball will have the advantage at the lower elevations, the elongated at the higher, and the respective initial velocities of each will determine the distance where the latter begins to acquire the superiority, which will of course indicate the value of this superiority; for if it do not occur within distances where practice is efficient, it is useless.

When the Cavalli gun was tried with the long 32-pdr. it was found that at 5° the ranges were equal; wherefore the better configuration of the trajectory would be of little service, because its advantages could hardly be said to be decided within the limits of certain practice.

Considering the weight of the Lancaster shell and the charge used, there is reason to suppose that the question of precision at available ranges, will depend mainly on the uniformity of the axial motion which, as before stated, cannot be usefully treated at this time for the want of data.

Power.

On this point there can be no doubt, that the Lancaster shell is much superior to the round projectile. For it not only has greater penetrative force from the greater momentum, even with its lower charge, but its content of powder is also greater.

But we think, that in defining the general power of a cannon, that which it is capable of exercising to a desirable extent, is understood. It is ascertained that a piece of 95$^{cwt.}$ is capable of discharging a 64-pdr. shot with the necessary force, and of continuing to do so through a course of firing sufficient for all naval purposes. Is it known that the same weight of metal will

endure as well the strain of the Lancaster projectile fired with a proper charge?

When a mass of metal is to be projected from a cannon, there is no form which yields more readily to the propelling impulse, than the spherical. Strictly it has but one point of contact with the bore, and when driven by the charge will rather roll than slide along the bore.

When the shot is elongated, it is in contact with the bore at more points than one,—it cannot roll, it must slide out. The friction is thereby increased even if the weights of projectile were alike; but as the elongated ball is also heavier, there is a farther addition to this obstacle.

The effort of the powder is of course to drive the projectile directly out of the gun, but the effect of the helical arrangement is to turn the shell, and thus, to a certain extent, it conflicts with the direct movement, which is enormous.

Here then are unmistakeable evidences that the strength of the gun is tasked in a far higher degree by the Lancaster than by the 64-pdr. shot, though the latter is driven by a considerably higher charge.

And the question is, whether the piece is equal to what is required of it by the new projectile. If it is, then it is certain that it may be also made to drive a larger and heavier round shot than the 64-pdr., so that the 95^{cwt} of metal

is either overtasked by the Lancaster projectile, or it is capable of developing a higher power with round shot; and the comparison now instituted is faulty, because it fails to convey a correct expression of the power which the weight of gun is capable of in both cases.

This is a practical question, and only to be arrived at by a course of proof.

It would be gratifying to have the power of adding the results of authentic and well conducted experiment, so as to place beyond doubt the practical value of the Lancaster cannon in regard to accuracy and power. But circumstances do not permit this, and it is therefore a matter of necessity to refer to the best evidence that can be obtained, which is that given by Sir Howard Douglas in his recent edition of "Naval Gunnery." This is authentic; indeed from the rank and opportunities of the writer it may be regarded as semi-official; but it is not sufficiently in detail, nor as precise, as would be desired.

The first public trial of the Lancaster cannon was made at Shoeburyness, August 7th, 1851.

On this occasion the peculiar mode of rifling seems to have failed in the only instance that the shell remained whole, as its range was indifferent and its motion very irregular.

The excessive nature of the strain, even with charges of 5 lbs. and 10 lbs. was manifested by the breaking into atoms of six shells out of seven that were fired.

In December, 1852, the trials were repeated, and with much better results. Seven rounds were fired with 10 lbs. and 12 lbs., and no shell broke—a range of 5600 yards was obtained at 17°. The deviations were inconsiderable. Sir Howard Douglas calls the shells spheroidal, or oval, and as the weights are not given, there is some doubt as to the meaning of the designations used. It is not certain, therefore, whether they were of the ordinary conical form or not.

It happened, however, that at the 8th round the shell stuck in the gun, and the practice seems to have ended.

So far as the information goes, the success attained in this instance should seem to have induced a prosecution of the experiment; but it does not appear that any action was had on the subject by the government, until August, 1854. And the circumstances of that time strongly point to the probability, that other reasons than those arising from a conviction of the general efficiency of the gun, led to the trials made. It had then been recognised plainly by the Naval Commanders of the Allies, that an attack by sea on Cronstadt would inevitably endanger their fleets, and certainly end in the destruction of many ships without the least possible advantage. It had even been thought necessary to land a corps, and reduce by a land attack the comparatively weak fortress of Bomarsund. The Lancaster held out the hope of battering the enemy's

works at distances far beyond the reach of the highest calibres of the common description. The alleged possession of these qualities would therefore naturally suggest the experiment,*—for the exigency was great, and the government could not but be deeply conscious of the responsibility inseparable from their position. Wherefore, even well founded technical objections might well be made to give way to the urgency of the occasion. We have no knowledge whatever, that such was the case, but suggest its probability.

Be that as it may, in August, 1854, practice with the Lancaster was executed, and according to the public prints, with much success, as "in no instance did the shells fall wide or short "of the target." But Sir Howard Douglas says;—"The greatest range obtained on that "occasion, was only 4500 yards† (shells 88 lbs.) "—a charge of 12 lbs. instead of 16 lbs, having "been used, from some distrust, we believe, of "the strength of the gun to resist the full charge, "and likewise to reduce the impulsive force, "which might otherwise have broken the shell; "but notwithstanding this diminution of charge, "one of the shells broke soon after it left the

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* "Since that an attack on Sveaborg has become easier. We "have now Lancaster guns," &c., &c.

Admiral Napier to the London Times, 1855.

† The Times says 5600 yards.

"gun. Though none of the shot fell wide or "short of the target at the long range, none fell "very near it. These experiments, not having "been made, however, for the ordinary purposes "of practice, but for particular objects which "are not disclosed, the powers of the gun and "the quality of the practice, must be judged by "the above results."

Some of the gun-boats that were to carry the Lancasters were now far advanced in their readiness for service; so much so, that by the 23d of August, 1854, one of them (the *Arrow*) was in condition to make a trial upon the rock called the "Needles." It is to be supposed that the authorities, political or naval, had been measurably satisfied with the capacity of the cannon they were about to employ as a means to surmount some of the difficulties before them, because the practice took place in presence of the queen and other notables of the kingdom. The distance was 4000 yards and six shells were fired. There does not appear to be much difference of opinion as to the results. The power for extensive range was fully maintained, but there was no approach to precision, and the firing was wild. However, the vessel had considerable motion, and as the gun was pointed over the broadside, it became impossible to distinguish the error of the piece from that of aim.

Two shells were broken in the gun, though they had been made of wrought iron.

Soon afterwards the *Arrow* took her departure for the Black Sea, and some of the Lancasters were also forwarded for general purposes.

Their application in actual service gave rise to a variety of statements from the correspondents of the press, and differing so widely that it is difficult to understand that they were speaking of one and the same operation.

One writer says, "Its success" (of the Lancaster) "has exceeded the most sanguine expec-"tations, and there is no doubt, that had we "more of them we might, in a fortnight, destroy "the whole town, shipping and fortifications of "Sevastopol, without the loss of a man on our "side," The correspondent of the *Times* says:—"The *Arrow* has been trying her long range "shot and shell with indifferent success. The "range indeed is enormous, but the flight seems "to be wide and inaccurate."

Some of the Lancasters were mounted in the land batteries, and took part in the general opening of October 17th, upon the Russian works. The effect is again variously stated by witnesses. According to the correspondent of the *Morning Herald*, it was most prodigious. "A battery of "20 or 30 such guns would destroy Sevastopol "in a week." But the writer for the *Times* says:—"The Lancaster guns made bad practice "and one burst." The *Illustrated News* has it, that "The Lancaster one-gun battery did not, "however, share in the general success. It

"never succeeded in striking the line-of-battle-"ship '*Twelve Apostles*,' which was the special "aim of its fire."

—"The Lancaster gun was left to fire at the "shipping, which it merely annoyed without "doing serious damage."

From such discrepant impressions of the same occurrence, it would be impossible to reach any satisfactory conclusion with regard to the performance of the gun on the occasion named, much less of its general capabilities.

From Sir Howard Douglas, however, we obtain some facts that are reliable.

He cites the practice at Bomarsund to demonstrate the inaccuracy of the Lancaster, saying:—"The Lancaster shells, of which such "high expectations were entertained, failed sig-"nally in precision of fire, even at 480 yards."

The character of the gun for safety has been much damaged by the fact that one burst unexpectedly in England and two in the trenches at Sevastopol. At Shoeburyness the piece was a 68-pdr. charged with 12 lbs. and a shell; when ruptured, "the fragments were thrown to con-"siderable distances, but happily no one was "injured, the firing party having from some dis-"trust of the gun's strength, been placed under "cover; had it been otherwise, a fatal catas-"trophe must have ensued, as in the bursting "of the guns at Malta and Gibraltar."

At Sevastopol it is said that one which burst,

killed four men and dismounted a 68–pdr. near it.

The action of the authorities in withdrawing the Lancaster from service, is conclusive as to the judgment of those who should be the most competent to decide. This measure, and his own general convictions, are thus stated by Sir Howard Douglas:—

"The withdrawal of the Lancaster elliptical-bored guns from the *Pelter*, gun-boat, at Portsmouth, and from the despatch gun-boats *Arrow* and *Beagle*, at Sevastopol, and the judicious order to arm all the new gun-boats with the 68-pdr. of 95^{cwt}, are necessary consequences of the very unfavorable reports which were made of those guns at Bomarsund, as being deficient in precision and not to be depended on, corroborated as these reports have been from very high authority on the spot, of the very bad practice made by the Lancaster guns at 1300 yards at Sevastopol in the land batteries, and the fact that two of them burst.

—"Though executed at enormous cost, and equipped with their peculiar shells, they have failed to accomplish on service the special purpose for which they were designed. They cannot, as has been proved, resist the charge (16 lbs.) nor stand the high elevation (18°) necessary to produce the vaunted range of 5600 yards; they are proved to be defective in precision in distant firing, and even at

"short ranges; and they have been withdrawn "from the despatch and other gun-boats.

—"No other uses that can be made of that "particular gun, whether it be to fire spherical "shot from its elliptically spiral bore, or, with "its own projectiles to bombard towns, can "redeem it from the verdict which men of "science in general pronounce, 'that they have "failed in the great objects for which expressly "they were made.'"

The accuracy in firing upon the works at Sevastopol, attested by some witnesses and ascribed by them to the Lancaster, were fully within the competency of the common 68-pdr. placed near it.

The ranges of which the Lancaster is found to be capable are thus stated:—

LANCASTER 68-PDR. OF 92^{cwt}.

Spheroidal Shell, (weight not given.)

Elevation.	1st graze.	Deviation. Right.	Left.
	Charges of 10 *lbs.*		
2°	1340 yds.	—	7
5°	2290 "	5	—
10°	3540 "	2	—
15°	4400 "	—	50
17°	5600 "	5	—
	Charges of 12 *lbs.*		
15°	4400 yds.	—	50
15°	4800 "	10	—
	Round Shot and 12 *lbs. Charges.*		
15°	3200 yds.	50	—
15°	3350 "	2	—

Attempts have also been made to dispense with rifling the bore, and to procure the rotatory movement by channelling the surfaces of elongated projectiles. Also, to dispense even with this, and consequently with the rifle motion, entirely,—substituting therefor certain peculiar forms which were supposed to have the power of preserving the apex of the shot or shell foremost. Numerous devices of this description have been submitted by inventors, and have been ordered to be tried by me, without success in any one instance.

The detailed accounts of these operations would no doubt be of interest, but I have already occupied more space with the subject than was at first contemplated, and must therefore postpone a more extended notice of these contrivances.

I may say, however, in conclusion, that the failure of these projectiles or of the Lancaster gun, is not to be considered as finally determining the interesting question of imparting the rifle movement to the shot or shells of heavy ordnance. Other efforts have been made which, though not so well known, promise to afford better results.

Certain it is, that much attention has been given to the subject, and very extensive trials executed; but the results that have been published, are not in a shape sufficiently authentic to be quoted.

IV.

FUZES.

Fuzes—their functions—defects—description of those in ordinary use.—Law of Combustion in Compositions.—regularity augmented by careful manufacture.—Case for Composition—wooden—metallic—paper.—Driving the composition.—Concussion Fuze.—Bormann Fuze.—Conditions requisite to constitute a good Fuze.—General efficiency much lessened by failure to ignite—by extinction after being ignited—by premature explosion.—French shell practice at siege of Rome.—Experiment to test the consequences of shells exploding within the bore—Doubts suggested by an incidental occurrence.—Percussion Fuzes—difficult to attain with spherical shells.—Exceedingly simple with conical projectiles.—Chances of a shell passing entirely through a vessel and exploding beyond.—Incendiary nature of shells.

THE important function of this minute detail, has made it the subject of much comment by almost all writers who have treated of practice with explosive projectiles. It is indeed an essential element of the shell—quite as much so as the powder that is to be exploded, or the iron case that encloses it; and very much more difficult to arrange satisfactorily.

The office of the fuze is to receive the flame from the charge of the gun—to retain it during the flight of the projectile to the object, and to communicate it in due season to the charge in the shell.

The difficulty of satisfying these requirements,

is very evident, and the common experience abounds in instances where the shell has failed of effect, because one or the other of the prime conditions of the fuze has been inoperative. Sometimes the flame has not been received by it, or if received, has been transmitted prematurely or too slowly. So that the shell did not burst at all, or it burst before reaching the object, or after passing through it.

The want of success in these respects from carelessness or lack of skill in the fabrication of the fuze, or the use of the shell, has brought more discredit on shell practice than is properly chargeable to it; and has led to much refined speculation and waste of ingenuity in the endeavor to remedy the evil by substitutes of innumerable variety.

Most of these have been utterly profitless. Very few have endured the first practical tests, and fewer can be said to hold out any promise of advantage even if successful. Among the former may be mentioned the Concussion Fuze, the Percussion Shell, and the Bormann Fuze.

The first is the ordinary fuze, with certain appendages designed to determine the explosion upon impact.

The Bormann Fuze performs similar functions as that ordinarily employed, and by similar means; but the development of its composition reposes on a much better principle, and is consequently much more regular in combustion.

The Percussion Fuze apparatus has nothing in common with either of these fuzes, in the manner of igniting the charge of the shell. It has no communication with the flame of the cannon's charge, and is unaffected by it,—nor is there any ignition to be produced until the shell comes into collision with its object. As a consequence, (if true to its purpose,) it avoids many of the difficulties that interfere with other fuzes, though practically it is found subject to others which are even more troublesome to deal with.

THE COMMON FUZE,

Depends for its action upon a cylindric column of inflammable composition, by which the flame is to be received, retained, and communicated to the charge of the shell. This composition is about as hard as slate, and is enclosed in a case of wood or metal, firm enough to endure the rude shock of firing, and so made as to prevent all access to the inflammable matter, save that which is designed.

The case is secured in the shell by driving, or by a screw thread, so that one end of the composition lies even with the exterior surface of the shell, and is exposed to the flame of the charge in the gun, the other end being within amidst the charge of the shell.

The current of flame which envelopes the shell on firing the gun, ignites the exterior end of the composition, and its layers are consumed successively, the combustion being prevented from passing down externally and lengthwise of the column, by the close contact of its case.

As the surface of the shell is variously presented to the action of the flame from the charge of the cannon, it is desirable that the exterior end of the fuze should be so placed as to receive it most advantageously. This may not be upon the inner hemisphere of the shell, because the entire force of the charge which is to give it motion, is exerted there, and the fuze would be thus exposed to the danger of instant destruction. The fuze is therefore turned outwards, and, by common consent, never below the plane of the axis of bore, as the current of flame from the cannon has its first issue through the space left above between the projectile and the bore, (windage,) and consequently the upper portion of the exterior hemisphere is more favorably exposed to it than the lower.

The length of the fuze is made to depend upon circumstances, (which will be stated in detail elsewhere); sometimes it extends across the cavity of the shell, sometimes it is so short as to be included entirely in the thickness of the shell. Those now used in England, and the United States, may project into the cavity, but never extend across it.

Compositions.

All compositions for fuzes are based upon the combination of nitre with sulphur and charcoal. Necessity has varied the proportions of the ingredients, but those commonly used for gunpowder are unquestionably the best, and the action of the fuze is prejudiced according to the extent of the departure therefrom. The gas evolved from the fuze made of gunpowder, issues with the greatest intensity, and is therefore more capable of resisting the ingress of particles of water, wood, or earth; hence the chances of extinction are diminished, and the common powder thereby furnishes the very best material for fuze composition.

The combustion of nitrous combinations is well known to depend upon the state in which they exist. When firmly solidified, the course of the combustion is comparatively moderate, and is perceptibly progressive, though, in a pulverous or granular form, it becomes so rapid as to seem instantaneous, and explosion ensues. Then, if common powder be compressed into a case of ½ or ¼ of an inch in diameter, so that the flame can only consume it in the transverse section, a lapse of 2½ seconds will occur in the burning of one inch, while a like quantity, in its granular state, will explode instantly upon ignition.

The rapidity of the combustion in a given mass is, however, proportional to the surface exposed; and, therefore, if the flame is permitted to extend itself to other surfaces of the mass, the consumption will be more rapid; and the intensity of the gas greater. Hence we have the principle of the rocket. But it may so extend itself as to resemble explosion in violence—as in the priming tube—when a minute perforation is carried through the whole length.

From this source, spring all the difficulties in regard to premature operation of the fuzes; for the existence of the least crevice in the mass of composition, in any direction, allows the flame to extend itself, hastens the consumption of the fuze, and therefore its action, so that the shell may be exploded before reaching its destination, to the total loss of its effects.

The excellence of the combination as it exists in gunpowder, has been made to yield to other conditions that seemed imperative. Thus the necessity of adapting the duration of the fuze, in some measure, to the immediate purpose in view, and the danger or impracticability of making the adjustment at the instant, has led to the arrangement of fuzes into classes, longer or shorter, as may be.

From this followed the necessity of other combinations, modifying the celerity of the combustion more or less. For which purpose, the usual practice has been either to obtain the composi-

tion by using gunpowder as a basis and adding to it a portion of the other ingredients, or else to make the desired combination entirely from the original elements. The defects of manipulation are soon perceivable in both of these modes of operation—for the character of the combination will depend on the purity of the ingredients, their proportion, trituration and mixture, and will vary just as these conditions are complied with. It is not difficult to obtain the proper quality of ingredients, nor to proportion them correctly; but the pulverizing, and blending them by manipulation, is notoriously imperfect, and affects both the uniformity and the extent of the duration. Every person who has had experience in such matters is aware of the tedious, vexatious, and uncertain results that are incurred in this way. The quantity of composition mixed at one time can never be considerable, because it is but mere dust, and absorbs the moisture of the atmosphere very readily. At every repetition of the preparation it is found that the duration of the fuzes varies more or less from the proper standard, and then follows the unsatisfactory expedient of adding one ingredient or another, until the wished for duration is obtained.

It is desirable therefore to have the composition prepared at the mills, and granulated like common powder—in which form it is not more liable to deteriorate than gunpowder, and can be

preserved for a long time without the possibility of alteration. Hence the proportions once fixed, the duration is established, with the least trouble to the pyrotechnist. The regularity of such composition is also greater. The effects of precision in the pulverizing and incorporating the materials, is shown by the following:—Certain proportions of Nitre, Sulphur, and Charcoal, were prepared at the Laboratory, and also at the mills of one of the best powder makers. From each of these was driven a number of Fuzes, which, when tried, resulted thus:

Nitre = 79.55. *Sulphur* = 15.91. *Charcoal* = 4.54.
Length = $1\frac{1}{2}$ in. Diameter = 0.34 in.
Condensed with a pressure of 2000 lbs. on the driver.

	Laboratory.	Powder Mills.
Duration	= 15 seconds.	9 seconds.
Variation extreme =	$6\frac{1}{2}$ seconds.	$1\frac{1}{2}$ seconds.

This seems to make any argument needless, in regard to the expediency of perfecting the mechanical process.

FUZE CASE.

This appliance serves the double purpose of confining the ignition to the surface intended, and also of properly securing the column of composition in the shell.

The most ancient expedient of the kind, was a wooden tube bored out to a suitable diameter for the reception of the composition. At the siege of Dole in 1632, when bombs began to be used as a permanent element of artillery, the fuzes were thus described by a military author of the period:—

"When these shells were filled with ordinary "powder, a wooden fuze or tube was inserted "through a hole above, entering as far as the "centre of the powder, and projecting outside "three or four inches; its bore was charged with "powder, sulphur, and charcoal, driven hard so "as to burn slowly: and in order that the fire "should not communicate before the proper "time, these tubes were very carefully luted and "pitched about the fuze-hole of the bombs."

(*Le passé et l'avenir de l'Artillerie*, 234.)

How little improvement has been made in this small essential, will be readily seen by every one acquainted with modern fuzes,—an account of which is now about to be given.

WOODEN TUBES OR CASES FOR FUZES.

The material for this purpose should be of a tough nature, not easily riven, nor affected by atmospheric changes.

The French "Aide Memoire Navale" mentions the Elm only: Colonel Charpentier,—Elm —Walnut—Ash—and Linden.

Captain de Brettes assigns the following value to several kinds, in order: Linden, Alder, Birch, Plane-tree, Elm, Walnut, and Ash.

The English use Beech, which also has been the custom of our service. The Gum too may be very suitable.

The wood intended for Fuze Cases, should always be roughed out nearly to the proper size, and left to season,—then trimmed to dimensions, bored, and put aside to season fully.

All such as are knotty or manifest any other imperfection, must be rejected as entirely unfit for the purpose.

The dimensions of the finished wooden tube or case are, 1.$^{in.}$25 in diameter at the head—0.$^{in.}$67 at the inner end; the bore 0.$^{in.}$25, not passing the entire length of the case, but stopping 0.$^{in.}$72 short of its small end, so as to leave it solid at that part, and measurably to obviate the danger of splitting. A globular cavity or cup is left for priming the outer ex-

tremity of the composition. The length of the case is to be sufficient to extend from the outer surface of the shell to the opposite side of the cavity, after being cut off smoothly outside. The flame issues into the shell by a perforation passing transversely through the inner end of the fuze.

It will be perceived, that in 1632, it was usual to allow the fuze to project 3 or 4 inches outside of the shell, and not to extend inside entirely across the cavity—which is just the reverse of the present practice. But so far as construction is concerned, there is no apparent difference in any important particular, between the venerable relic of Dole, and the most recent wooden fuzes. So that no improvement can be said to have been made from that period in the principle of the appliance, nor even in the detail, until Paixhans had broken in upon the heavy slumbers of routine, and succeeded in bringing into use something better than the old fixture just as it had been handed down, covered by the dust of ages, and respectable for its antiquity, if for nothing else.

METALLIC FUZES.

In the "*Nouvelle Arme Maritime*," where the distinguished artillerist recounts the details by which he may be said to have created the Naval shell-system, will be found the description of the substitute which he proposes for the wooden cases. This is metallic and, like the other, to extend across the cavity, but it is to be screwed, not driven in.

In the United States and England, wooden cases have, for some years, given way to the metallic. They are made of the toughest gun metal (nine parts of copper and one of tin, no zinc whatever)—are screwed into the shell, and sometimes enter into the cavity, but without extending across it.

The position of the fuze varies—being either in the axis of the bore, or upwards at an angle of 45°, and always outward.

But the wooden case obviously requires to be placed in the axis of the bore; for as the shock of displacement occurs in that direction, it is exerted obliquely upon the case when at an angle of 45°, and would break it or cause it to yield sufficiently to dislocate the composition and injure its action. This is avoided when the direction of the case corresponds with the axis of bore; and the wooden case being long

enough to extend across the cavity, and receive support from the opposite side, cannot be forced in.

The metallic case may be used in either position—if in the axis of the bore, it is secured against being driven into the shell when the gun is fired, by the screw threads assisted by a stout flange or shoulder at the outer end. If inclined upwards, it cannot be bent much, provided the tube is of sufficient stoutness, and does not project much into the cavity of the shell. Wherefore the long case of Paixhans, though metallic, is not to be recommended when the fuze is to be inclined to the axis of the bore; for though less liable to damage than if of wood, yet as already stated, the least crevice or fissure is fatal to the regular action of the combustion, and no very material distortion of the case might suffice to do this mischief.

The length of the U. S. Fuzes corresponds with the thickness of the 8-inch shell at the fuze-hole, and they are therefore supported along their entire length.

The English cases vary in length.

Paper cases.

These are sometimes used in metallic cases to prevent the contact of the composition therewith; for the decided affinity between the nitre and sulphur of the latter, and the bronze, is quickly developed by the moisture of the sea air, to the detriment and final destruction of the composition,—and this cause is rendered still more active in steamers, by the escape of the hot and moist vapor from the machine, which pervades every part of the vessel; so that, without extraordinary care, all kinds of laboratory stores are liable to speedy deterioration in such ships, as I have had occasion to notice in those returned from service.

When the metal case is immediately in contact with the composition, the moisture that may reach the fuze is absorbed by the composition and damages it—then follows the action of the acids upon the metal, and ends in the eventual ruin of the fuze, sooner or later.

The paper case is a more ready absorbent of moisture than the composition,—and so long as the quantity that may be present is not beyond its capacity, the composition does not suffer. So that this part of the difficulty is remedied in a degree, while the contact of the composition with the metal, and its consequences, are abso-

lutely prevented by interposing the paper case between them.

The paper case is also useful when the charges of the piece used are proportionally low, and the first movement of the shell is not so violent as to need full precautions against its action. Thus, in mortar practice, it is the custom of our land service to drive a short wooden case into the bomb and insert the paper case with the composition just before firing. So with our light boat howitzers,—which gives the means of using such a time of fuze as may be deemed suitable to the distance of the object, and each shell or shrapnel is provided with five fuzes of 1, 2, 3, 4 and 5 seconds respectively, put up in a water-proof package.

Some care is required in selecting paper for making cases; it should be stout, the texture even (and rather open so as to permit the cement to permeate) and the surface slightly rough, but not coarse, in order to favor the adherence of the surfaces.

The cement is made of a refined glue, known as "bonnet-glue," used rather thin, and kept warm in a suitable vessel.

The paper is cut into slips having one end square, the other tapered to a point,—the workman uses a steel cylinder 2¼ to 3 inches long and 0.34 of an inch in diameter, around which

he rolls a paper slip upon a smooth board, beginning with the square end and applying the cement throughout wherever the surfaces are brought together,—the gradual diminution of the other end of the paper produces the required taper on the exterior of the case. The edges of each fold remain, however, and are smoothed down with a sand-paper rasp when the case is dry.

If one of these cases is cut in any part, the several layers of paper are not perceptible, but appear as if resolved into a perfectly firm and homogeneous material.

The finished case is one-tenth of an inch thick at the upper or larger end, and half a tenth thick at the lower or smaller end.

Driving the fuze composition.

It is customary to pulverize the grained material before using it,—but this is by no means indispensable when a mechanical power is employed.

The composition may be driven by hand, or by a monkey, or by a machine.

The mallet and drift have been in use until recently, and will probably continue to be the common resort for driving fuzes on shipboard, when the exigencies of service may render it necessary.

The monkey is said to be used in some of the European laboratories.

In the Ordnance Department of the Navy, a screw-press, contrived by Mr. Goell, has been employed since 1846. It is a most ingenious and convenient machine, doing all the work now required of it and capable of much more.

The driving shaft moves vertically through a wrought iron tube, on the exterior of which is a strong square thread.

A nut works upon this, by means of a large disc attached to it of sufficient diameter to create the requisite power, and upon the upper side of this disc is established a set of levers.

If the material is to be driven into paper or wooden cases, it is necessary to secure them first in a steel mould, which is made to adjust so closely to the exterior of the cases, as to sustain them against the pressure applied in condensing the composition. If driven directly into metal cases, it is only required to have sockets on the plate of the machine, which shall present the tube fairly to the direction of the force.

Two or more of these moulds, or sockets, are placed around the edge of the circular plate carried upon the lower part of the frame, and revolving so as to bring the moulds in turn to the drift.

The workman pours in a ladleful of pulverized gunpowder, or composition, as the case may be, and enters the drift (which is of the

same diameter as the forming mandril) moving round the lower plate, so as to bring the drift under the driving shaft of the machine; the positions being determined by a spring and catch working into a notch in the edge of the plate.

The boy now gives the disc a quick whirl by the handles, and the driving shaft descends on the drift—he sustains the movement, and increases the pressure until the sound of the bell notifies him that the lever has risen and the action of the machine has ceased. He then reverses the motion of the disc, and raises the shaft sufficiently to allow the workman to revolve the lower plate and bring in place another mould, which has meanwhile been charged with a ladleful of composition. In this way the operation proceeds until the column of condensed composition is rather longer than required.

The power usually applied is about 2200 lbs.; with a double mould a man and boy can drive 120 fuzes in a day.

In this way the powder or composition is solidified until its density is doubled, and it becomes as hard as stone.

When driven by hand, a mallet of about 8 ozs. is used, and each charge is struck blows in quick succession, which produces a condensation about equal to that of the Goell Fuze Press with a force of 1900 lbs.

Each charge should be so regulated that its

height, when condensed by pressure, or driving, should not exceed its diameter, and in general a greater equality is obtained when the layers are of less height.

The paper cases are removed from the driving mould and placed in another of the exact length required; the projecting portion of their fuzes is then cut off evenly with a very sharp knife.

The composition or gunpowder, thus compressed, is quite hard, and its specific gravity, as obtained in the ordinary process of the laboratory, is rather more than double that of gunpowder in the grain.

PRIMING.

It has always been customary to prime fuzes. Those of wood have a cavity at the head, as already stated, and the composition being driven fair with the lower part of this cavity, the cup is charged with a paste of mealed powder and spirits of wine, or tincture of camphor, among which is interspersed a few threads of quick match. The same priming is applied to composition driven in metal or wood, only that they have no cavity, and a part of the tube is left unfilled in order to receive the paste.

There is good reason to believe that the

priming of fuzes by paste or any other material, is wholly needless, and that the composition will ignite quite as well as the priming, —a striking evidence of this is found in the Bormann Fuze. When cut for use, the very minute surface of four-hundredths of a square inch of hard driven composition, is presented to the flame of the gun; and yet, in a very large number that I have fired from light guns, the failures to ignite are much fewer than the best primed fuzes freshly prepared. Originally, the inventor made use of a central priming, but it proves to be unnecessary, and has been dispensed with. The objection to priming of any kind is its exceeding susceptibility of moisture, and its destruction by dampness, which would not affect the smooth, hard surface of the composition.

The inner end of the fuze may be left open to transmit its blaze to the charge of the shell; or it may be closed, and transversal holes drilled near the lower end of the case. When the latter practice is followed, the advantage is gained of being able to support the fuze case against the opposite side of the cavity, and preventing its being forced in. But whether the case is thus sustained, or is merely secured at the fuze hole, the closing of its end prevents the displacement of the column of composition, which probably is of more frequent occurrence than with the case itself.

The fuzes of the English Navy, as described by Sir Howard Douglas, (271,) have the metallic case with a screw cap, and the composition is driven in without the intervention of a paper case.

They have three times:—2 seconds—7½ seconds—and 20 seconds; of 1¼, 3 and 4 inches in length, and designed for the distances of 600, 1800, and beyond 1800 yards, respectively. The first and last are driven with composition; the other (7½ seconds) with mealed powder.

The French, if we may judge from their *Aide Memoire*, only use the wooden fuze, and it may be presumed that the opinion given by an able writer* on the subject, is probably that of the authorities who direct such matters in the French service, viz:—

"The fragility of wooden fuzes which, in long "cannon especially, are liable to be broken by "the collision of the projectile with the bore, "their rapid decay at sea, the deterioration of "the composition, which it is difficult to pre-"serve from moisture, notwithstanding the care "taken against atmospheric influences, have "caused efforts to be made to substitute metal-"lic fuzes for wooden fuzes screwed into the "eye of the shell. But the metals being ready "conductors of caloric, it is to be feared that "fuzes so made would absorb it from the com-

* Charpentier, Colonel of Marine Artillery.

"bustion, so as to increase the chances of extinc-
"tion to the fuzes in firing; while wood being
"on the contrary an indifferent conductor, car-
"bonizing even at red heat, can in collision
"rekindle the extinguished composition with a
"spark. This property in metals of conducting
"caloric freely, may also make it to be appre-
"hended, that the extremity of the metallic fuze
"in contact with the charge of the shell, may be
"so heated as to fire it and produce explosion
"before the shell has attained its object. For
"these reasons we do not hesitate in giving a
"preference to wooden fuzes with such defects,
"over those of metal."

Concussion fuze.

Is the ordinary Fuze just described, with some arrangement by which the flame of the fuze is made to have access to the charge of the shell upon collision with the object.

Its sole purpose has reference, consequently, to the probability of the shell passing entirely through an object before the explosion, which may occur afterwards, and therefore be ineffective. This is generally apprehended at very short distances, when the velocity of the shell has not been materially diminished.

The possibility of such an occurrence cannot

be doubted, and it would be judicious to guard against it, if no other quality of the fuze were to be prejudiced thereby; but all the devices that have yet come under my notice in the official examinations of various inventions, were complicated to a most objectionable degree, and proved exceedingly uncertain in their operation; for they increased the failures of the fuzes very frequently.

BORMANN FUZE.

The use of this excellent and ingenious fuze has, so far, been confined to the shells and shrapnel of light artillery. What objections may arise to its use in heavy calibres, has not yet been ascertained by actual practice, though its great regularity and convenience, may well render it exceedingly desirable for the Navy.

Its peculiar excellence consists in the driving of the whole mass of the composition by a single pressure, and its disposition in such wise that, the combustion occurs *not with* the stratification of the mass, but *transversely* to it: whilst in the ordinary fuzes, the solidification and the process of combustion are just the reverse,—that is, the column is composed of a number of layers, solidified successively by an equal pressure, but as the inferior layers have, beside the pressure ap-

plied to them, to bear that of the superincumbent layers, it follows that the mass is not homogeneous, but increases in density with the inferior position of the layers.

The regularity of the Bormann fuze in burning, is very great, more so than that of any other kind which I have seen.

As the use of this fuze has hitherto been confined to shrapnel, its detailed description and use will be found in the revised Memorandum on that subject.*

General considerations.

A glance at the conditions required to constitute a good fuze, will serve as a standard whereby to estimate the relative values of those described, or of others which may be devised.

1st. The fuze must ignite with certainty.

2d. It must be able to sustain ignition against the action of particles of earth, water, or wood, that may be obtruded upon it.

3d. It must not act before reaching its object.

4th. The duration should be nearly uniform.

It is almost impossible that any species of fuze should be absolutely perfect, so that it only remains to choose such as may be least imperfect.

* See 2d Edition—1856.

1st. THE FAILURE TO IGNITE.

When suitable opportunities for observation occur, it is noticed that in firing a number of shells, many do not explode, and when examined, no trace of ignition can be detected upon the fuzes.

It seems hardly credible that material of the least combustibility can escape ignition when exposed in the usual way on the surface of a shell, which is enveloped by the fierce and searching flame that rushes over the projectile at the firing of the charge in the gun. If then there is a failure to ignite, it must be supposed either that the fuze has been deprived of its combustibility, or has not been properly presented to the flame. So long as it is placed in the upper hemisphere of the shell, it is difficult to conceive that the latter cause should exert any agency in this matter, and we are therefore unavoidably compelled to look to some defect in the fuze itself.

Some believe that the composition is made difficult of ignition by the nature of the surface produced, when the hard composition is pared off smoothly to proper length, by a keen cutting edge—others think the surface presented is too small; accordingly it is customary to complete the exterior end of the composition with a paste

of pulverin and alcohol, interwoven with delicate fibres of quick match,—and to give all convenient superficial extent to this priming.

It is noticed, however, as already said, that no fuze is more free from failure of ignition than the Bormann fuze; and in this the flame always operates on the hard composition, and the surface exposed is of the least possible extent—far less than customary in fuzes of any other description. And so sure is it recognised to be of combustion, that the priming chamber, originally devised to meet objections, has been suppressed.

Thus the necessity of enlarging the orifice, as well as the use of priming, are evidently invalidated by the experience with the Bormann fuze —and strong objection exists to the use of these devices, because the priming is far more susceptible of moisture than the hard composition, and is ruined by it at once. Nor is it certain that the strong current of flame does not often brush off the dry and dusty priming as it lies loosely on the head of the fuze, whilst the enlargement of the external orifice, offers a greater facility to the ingress of particles of extraneous matter, and therefore endangers the combustion.

The benefits of these devices being therefore very doubtful, and their defects very certain, it seems advisable to avoid both.

The failure of the composition to ignite, is probably due to the same cause which unfits the

priming for its purpose,—the absorption of moisture. Every one who has been within the vicinity of the Ocean is familiar with the all pervading nature of its atmosphere, and when we consider the influences that are developed by it, and co-operate with it in the deterioraton of every substance that is presented to such action, it is not surprising that compositions which, contain so ready an absorbent as charcoal, and are injured by the least dampness, should often be reached, notwithstanding every precaution. Still it has not been found difficult to exclude atmospheric influences in sailing ships, judging from the condition of the fuzes returned from service, as well as by the results of shell-firing at sea. Very different is the case in steamers, where ordinary precautions are by no means effective, and all kinds of laboratory stores are frequently returned irreparably damaged.

2d. Extinction of the fuze after having been ignited.

This may be expected to occur frequently when the shell ricochets on soil or water, or enters the object fired at. If this be timber, every external orifice of the shell is found closely packed with the minutest fibres of wood, so firmly solidified that a sharp tool and considerable force is needed to remove the substance.

When shells do not explode, it is impossible to know whether the fuze has failed to ignite, or has been extinguished subsequently, unless the shell be recovered and examined; and even then the indications do not always serve.

An idea of the general result is obtainable, however, from practice executed with particular reference to the question.

Thus, if a number of shells be fired at such elevations that the time of flight considerably exceeds the duration of the fuze, it is inferable that the fuzes of the shells which did not explode, failed to ignite. If the shells be ricochetted and the number of failures be increased, it is usual to consider the difference as due to the action of particles from the surface impinged on. And finally, if the shells be lodged in any object, the full extent of failure from all causes, is supposed to be reached.

The English experience with their own fuzes may be thus abridged from the statements of Sir Howard Douglas.

In 1838, 86 shells were fired experimentally at the *Prince George*, distant 1200 yards—80 struck, and of these, 38 did not explode.

In the ricochet practice at Southsea, 1838—32 shells were fired, of which only 5 burst.

In connection with these facts, Sir Howard Douglas remarks;—

"It is found that four fuzes out of five are "extinguished on striking the water, and about

"one in three on striking a ship; if the shell "strike with the fuze end forward, which is ge- "nerally the case, it is found that the timber "by its resistance, forces itself into and effec- "tually plugs the fuze." (281.)

And at p. 245—"The chances of extinction "by water are 4 to 5,—by the object, 1 to 3."

In the *Excellent's* Tables, it is noted,—"Rico- "chet ranges are not given for shells, because "the present fuzes are always extinguished when "so used."

This is rather discouraging, and it is recommended to our officers to note the results of their own practice, in order to ascertain how far they will compare with those given by Sir Howard Douglas; which, though executed so long since, appear to be intended to represent an existing state of things not materially improved since the date of the practice given.

It may be observed, that nothing seems more fatal to the combustion of all kinds of fuzes, than particles of sand; it is therefore of importance to avoid ricochet on such a soil; water is not so detrimental, but its effects are well-marked.

Whether the non-performance of fuzes be due to their failure to ignite, or to subsequent extinction, it will be found that those made from gunpowder are the most sure against both causes. Wherefore, as a general rule, when it is possible to choose, the preference ought always

to be given to such; their combustion is more perfect, never expending itself in the ejection of little globules of burning matter which mark the predominance of sulphur, and in detaching themselves, weaken the force of the combustion —nor is there an unnecessary loss of material from residuary deposit. The gases are evolved with the most energy, and therefore repel most successfully the obtrusive matter which is sure to extinguish the combustion, if once in contact with the ignited surface,—for be it observed, that well constituted compositions cannot be extinguished merely by occlusion from the atmosphere.

3d. Premature explosion.

This may be caused by the increase of the ignited surface of the composition resulting from cracks in the case, or in the composition itself, or by interstices between the case and the composition,—and in proportion to the extent of this cause, so will be the increased celerity of the combustion. The composition may be consumed instantly, or, perhaps, at no greater rate than will suffice to carry the shell near to the object.

Wooden cases are alone liable to be cracked, and this may be due to want of proper support

to the case in driving, or to the subsequent operation of atmospheric influences; this defect constitutes the strongest objection to the use of such material.

Crevices may occur in the composition from some defect in the tools or in the mode of using them, or they may be created by the bending of the case in the shock of first movement, and the consequent separation of the layers of the composition from each other, or from the case itself.

It may also happen that the displacement of the shell by the charge of the gun, will force in the column of composition, or the case with it. This would of course cause the shell to explode very quickly,—and to this class of accidents, all fuzes are liable, whether their cases be of wood or metal.

The shell may be defective in thickness or quality of metal, and be crushed by the force of the charge, when the explosion will be caused in or near the gun. Sir Howard Douglas is of the opinion that the bursting near the muzzle should be attributed to the detonating qualities of the powder in the shell.—(320.)

It is manifest that the premature explosion of shells is far more detrimental to their efficiency than the failure to explode at all; for in the one case, there is a total loss of any effect whatever, with some risk of disadvantage to one's own gun if the shell burst in the bore; or to the people if it occur near the muzzle,—while

in the other case, the shell may at least perforate and be as serviceable as a shot, if it fail as a shell.

In the practice upon the *Prince George*, already cited, it seems that there was only one case of premature explosion, to thirty-eight failures to explode.

But in the official account of the engineer and artillery operations at the seige of Rome, in 1849, it is noticeable that the French fuzes were very subject to this defect; and the consequences were proportionally injurious, as the following statements show:—

—"June 14," (Note.)—"Nearly all of the "fuzes of the shells burst before the projec- "tiles reached the object. This bad quality of "the fuzes and the weakness of the carriages, "rendered the 22$^{cent.}$ howitzers nearly useless "during the seige of Rome.

"The defects of fabrication of the fuzes were "not confined in their consequences to the fire "of the howitzers. The mortars also lost a large "quantity of the projectiles, which sometimes "burst over the heads of our workmen, making "it necessary either to suspend the fire, or to "change its direction.

"These fuzes were furnished partly from the arsenal at Antibes, and partly by the navy.

—"June 23d.—The mortar battery had so "arranged its fire, as to throw shells at night "into bastion 8. But some of them having burst

"above the trenches, and their splinters hav-
"ing reached our workmen, the fire was sus-
"pended at the request of the commanding
"engineer," &c.

The character of the fuzes here spoken of, are not mentioned; but it is believed that the cases were of wood, while those of the English were metallic.

It cannot be supposed that the French would have permitted such results to arise from any neglect to secure the best means at disposal; for the check received in the initial operations from the Roman Republicans, who repulsed the French *avant guarde* and rudely threw it back upon *Civita Vecchia*, was not likely to lead to any further exhibition of excessive confidence by using means inferior to the best; while the political circumstances which brought about the siege of Rome, might be expected to induce the criticism of the motive, as well as the execution of the measure.

Moreover the publication of the details seems to have been entirely voluntary, having been consented to by the Minister of War, at the request of the Commanders of Artillery and Engineers,—From which we infer that the operation generally was to be considered as a frank and fair exposition of the condition of the two arms.*

* Siége de Rome. 1849. Journal des operations de l'artillerie et de Genie publié avec l'autorization de Ministre de la Guerre.

Doubts having arisen in regard to the danger of splitting the chase of shell-guns by the accidental explosion of shells therein, some trials were made upon a piece of ordnance, that are not without interest.

A shell was put in, having a Bormann fuze cut close to the communication with its magazine; the gun was fired, and this was repeated twice. In each case the shell was found without the least evidence of having exploded.

The gun was loaded with the fourth shell filled with powder, (6 lbs.), without any fuze, and the fuze-hole open, so that some of the powder escaped from the shell like a train,—the gun was fired and the operation repeated afterwards. In both cases but one report was distinguishable, and about a dozen fragments were seen following the general direction of the gun, but spreading out considerably in their flight, the extent of which was nearly a mile. None of them flew laterally, and there were no marks perceivable on the bore of the gun.

Not long afterwards the same gun was loaded in the same way, except that it had the reduced charge of 5 lbs. instead of 15 lbs. In this case two reports were heard,—perfectly distinct and yet in most rapid succession. The fragments of the shell flew laterally as well as directly, and some even inclined about 45° rearward, showing that the shell must have burst *outside of the muzzle of the gun.*

The vicinity of some houses made it dangerous to proceed farther at this time.

It is seen in the first place that, though the fuze was cut so as to allow free access of the flame to the magazine of the fuze, yet that the shell lodged in the sand bank, and the powder in the shell was not ignited.

2d. That two shells, without fuzes, exploded in the bore, leaving no indications of the part of the bore where this occurred. Hence we are restricted to the supposition that it occurred near the original position of the shell in the bore, and therefore in the thickest part of the gun.

3d. When the charge was so small as to impart a very low velocity to the shell, much lower indeed than would probably be used in service, the explosion of the shell, also without a fuze, occurred plainly outside of the bore. The charge of the shell was fully exposed to the current of flame, and the shell must have moved not less than a dozen feet before the combustion of the powder in the shell had sufficiently proceeded to develope the explosive tension of the gases.

The lapse of time between the sound of the two explosions was perfectly distinct to myself, and to others who were near; but it was clearly impossible to do more than to recognise the interval,—its appreciation was impossible.

It is known that the construction of the Bormann fuzes was such, that by cutting them close to the magazine no composition intervened be-

tween the flame of the gun and the grained powder in the fuze. It is also known that the powder in the shell was not exploded,—the traces of combustion appeared in one fuze, but the others were totally destroyed by the impact, so that it is impossible to say certainly that they had been ignited, and then extinguished—it is only supposable from the general certainty of this fuze.

The explosion of a single shell beyond the muzzle in the manner described, is suggestive of doubts in regard to the common notion that fuzes are capable of exploding the shells in the bore of the gun. For there is an intervening substance—that of the fuze—through which the flame must travel, or which must be displaced; and however quickly this may done, it can hardly be assumed to be equal in celerity to the explosion of powder exposed to the action of the flame under any circumstances; which in one case certainly has been known to be less rapid than the movement of the projectile. That shells are broken in the gun is an incident of common experience, but it remains to be ascertained with precision if this is to be ascribed to the premature action of the fuze, or to some other causes,—such as its being crushed by the shock. Sir Howard Douglas, it has been stated, considers the accident due to the detonating property of the charge of powder in the shell.

4th. IRREGULARITY OF DURATION.

The consequences of this defect are various. In the case of shrapnel it is nearly fatal to its efficiency, as noted in another Memorandum on that subject.* With heavy ordnance it is of less consequence, though it may often produce a like result, and have the same consequences as premature explosion. Still, as a general rule, this is not to be apprehended; and with the necessary care in fabricating and preserving fuzes, it is probable that, unless the variations in duration are unreasonable, they need not have any important effect on the general practice.

PERCUSSION FUZES.

In view of the progress that has been made in every branch of human industry, it may seem singular that so important an appliance as the fuze should not have advanced beyond the primitive article used in the earlier epochs of explosive projectiles.

The serious difficulties that beset the question have just been enumerated. Fuzes fail to ignite; or they may be extinguished after ignition; or act too soon, or very irregularly. The use of a detonating agent seemed to present the means of avoiding these insuperable difficulties,† for

* Boat Armament, 2d edition. † Sir Howard Douglas, page 298.

it proposed to create the flame only when needed at the instant of impact, and its action upon the charge of the shell was to follow instantly upon its own development.

The ingenuity of inventors was precipitated upon the solution of the problem at its first suggestion.

But upon the very threshold of inquiry, it was evident that, if the new fuze avoided the difficulties of the old, it was not free from others of a different and quite as difficult a character.

The essential requirements of a good percussion shell were:—

1st. The detonating agent was to yield instantly to the concussion produced by collision with the object.

2nd. But it *must resist* the shock given to the projectile when displaced by the effort of the charge; and this was known to be enormous.

3rd. Having survived this danger, it must still be proof against the consequences of impact with the material of any surface on which it might ricochet, accidentally or designedly.

It was evidently not easy to satisfy conditions so conflicting and delicate in their nature, particularly as they probably varied in degree with each round which was fired, and that in a manner quite beyond all conjecture.

Moreover, it was not merely to procure a shell that would ordinarily perform its functions in

this way, but it must also do so with more certainty than those which were commonly used.

In the English Navy the name of Captain Moorsom appears most prominently in connection with this subject; but so far as any judgment can be formed from what is known positively, it does not appear that his invention has been perfected so as to supersede the common shell, or even to get beyond its experimental application.

Sir Howard Douglas states that in course of practice with the Moorsom shells upon the *York*, (1853,) it was noticed that they frequently failed to act even when new. Several 8-inch shells struck or passed through and did not act. One of them pierced the side and struck the other without exploding; and many of the Moorsom fuzes were picked up entire, among the splinters and fragments. (318.)

Sir Howard Douglas, however, says that the problem is prosecuting with every "prospect of success."

The French percussion shell is the contrivance of Captain Billette; but nothing is known publicly of its qualities, and it is believed that only a small portion are furnished for service, which is not very favorable to its character.

The embarrassments that beset the efforts to realize an efficient percussion shell of the ordinary spherical form, soon gave another direction

to the labors of the parties interested. The problem was very evidently most simple and obvious of solution, if it were possible to have the projectile present a given part to the impact; but to do this, it was requisite to change its form from spherical to conical, and as we have already seen, this was found to be only a shifting of the labor from one field to another; with as little success too, notwithstanding the increased advantages that would result from this mode of attaining the object—for, with the conoidal projectile, came greater power and enormous range, as well as the simplest percussion mechanism.

So far, this interesting question has proved to be a perfect riddle to ordnance men, leading them frequently into fanciful speculations as wide of probable fulfilment as the search for the philosopher's stone, or the squaring of the circle, or the North-West Passage.

And when some future Œdipus shall grasp the problem in all its bearings, it will remain to determine the comparative efficiency of the percussion and the common fuze, or as Sir Howard Douglas styles them, time-fuzes.

We know that the action of shells is regulated by the extent of their penetration. When the explosion encounters equal resistance on all sides, its action also is equally distributed; but when its penetration is less than sufficient for this purpose, the explosion naturally finds egress

in the direction where it encounters least resistance.

Now, the legitimate tendency of the time-fuze is never premature; on the contrary, the objection usually offered is, that it may not act promptly enough, and as a consequence, at short distances, it may pass through both sides before the fuze causes the explosion. To this, the supposed nature of the percussion fuze is not liable. But whenever the distance is increased, so that the probability of perforating the entire mass of the enemy no longer exists, then the shell fitted with a time-fuze has the opportunity to make its full lodgment before the explosion occurs; under like circumstances, what will be the comparative action of the shell which is exploded by the collision? Certainly, if it explode before full lodgment, so will the effect be proportionally lost, and the explosion expend itself in blowing off portions of the outer surface, whether the distance of the object be more or less.

It will then be to determine whether the explosion of the charge in the shell, does or does not occur so instantly, that the penetration is necessarily superficial.

Sir Howard Douglas is of the opinion, that "the shell *cannot* be lodged in the wood, if the "percussion apparatus performs its function." (p. 250.)

If so, then it is useless to proceed with any

farther attempts to obtain a good percussion shell. But it does not appear from any published facts, that this has been satisfactorily demonstrated, or even investigated; and from a few isolated results, there is reason to believe in the propriety of considering it an open question.

No little concern is properly entertained in regard to the apparent liability of shells to pass through the side of an opponent before the fuze can cause explosion, the effect of which is then expended uselessly; and this evil seems to become very serious at short distances, when the projectile occupies hardly more than a second in its transit.

It will be remembered that the advantage claimed as inherent in the percussion and concussion fuzes, is immunity from this accident.

But there is reason to believe from observation, that the United States fuzes, and others of similar description, are liable to be dislocated by the shock of impact, and thus made to explode the charge of the shell almost instantly after penetration.

Should it prove true that a liability to this accident is of frequent occurrence, the presumed want of effect from dilatory explosion, would be removed to a considerable extent, and one serious objection to the common fuze be obviated.

There is reason to apprehend that the alleged failure of shells to explode, is not always to be

charged to the defects of the fuze; there are well authenticated instances where shells have been recovered, and on examination the caps were found in place over the fuze, thereby very fully preventing the access of the flame and the ignition of the composition.

It is well therefore to warn the seamen fully on this point, so that the projectiles may have an opportunity of taking effect, and their defects not be magnified unduly.

Experience has already made manifest the incendiary properties of shells, in the frequent occurrence of conflagrations when they have been used. In this tendency, the common fuze necessarily participates to some extent; for the escape of an intense though small stream of flame is not to be disregarded when gunpowder or any very combustible material is at hand, as even its presence may suffice to produce the most disastrous results.

It is evident that the tendency of the percussion and concussion fuzes is to operate upon the first sufficiently solid material struck by the shell; therefore, their explosive and incendiary capacities, however great, will seldom or ever be exerted upon magazines, shell-rooms, engines or interior parts of the ship, because the sides and other intervening materials must determine the explosion invariably upon themselves.

V.

PENETRATION.

Condition and incidents—equation therefor.—Penetration in oak of several calibres.—Origin and anomalies in practice on targets—more particularly caused by inequalities of resistance.—Differences between penetration in target and in naval structures.—Thicknesses of French ships.—Anomalies in practice upon ships—due to unequal resistance of structure and to the shock of the ball—complication of effect during an engagement. Deductions from target firing.—Practice upon target by the Ordnance Department of Washington Navy Yard.—Perforation—effect on fuzes.—Concussion.—Ricochet.—Remarks.

THE depth to which a projectile fired from a cannon can be made to enter into any substance, will depend on the force of the ball; upon the manner in which the surface struck is presented to the trajectory, the character of the substance, and its disposition.

The force of the blow proceeds from the weight, volume, and velocity of the shot or shell. They constitute its momentum or power to overcome resistance,—first, of the air through which it must pass to reach the object, and then of the object itself.

The relative momenta of projectiles on striking, may be considered as proportional to their

initial momenta when their weight and volume are similar, but not otherwise. On the contrary, a larger projectile may be inferior to another in its initial momentum, and yet retain a greater degree of power at a distance, for the following reasons:—

First. The resistance of the air to the ball is proportional to its volume in the ratio of the diameter ^{2}.

On the other hand, the power of the ball to overcome this resistance lies in its weight and its velocity.

The weight of the ball increases with its diameter^3,—consequently in a higher ratio than its surface,—and hence the larger the ball the greater is the increase of the means of overcoming the resistance of the air.

Therefore, in horizontal fire, the larger ball moving with a certain velocity encounters less resistance proportionally than a smaller ball moving with the same or even a somewhat higher velocity, and derives from its greater weight more power to overcome it; consequently, will retain a greater proportion of its momentum, at equal distances, than the other. Moreover, the resistance of the air increases in a higer ratio than the increase of the velocity. Hence a ball moving at a certain rate, loses more of its velocity than a ball of like kind moving at a lower rate.

Thus, if an 18-pdr. be fired with an initial velocity of 1600 feet per second, and a 32-pdr. with an initial velocity of 900 feet per second, their initial momentum will be equal, (28,800); but as they proceed, the velocity of the 18-pdr., and consequently its momentum, will decrease far more rapidly.

When the specific weights of projectiles are unequal, there is a corresponding disproportion in one element of power, while the resistance still remains proportional to their volumes. Wherefore, shells being hollow, are of inferior density and liable to this disadvantage.

These general laws were most clearly defined by Robins about a century since, but the difficulty of determining the exact ratio of the resistance to the different velocities, has interfered with their useful application.

They are now so far understood as to permit deductions of some reliability to be made from established facts; so that the average penetration of shot or shells into a homogeneous mass of wood, can be computed with tolerable precision at all practicable distances.

The experiments executed at Gavre, and at Metz, by the orders of the French government, furnish the most satisfactory data that are to be had at this time, for a general hypothesis regarding the penetrations of projectiles into the solid material commonly used for ship building.

The formulas, as finally revised, are given thus:—

$$u = \frac{v}{\left(1+\frac{v}{r}\right)e^{yz} - \frac{v}{r}}$$

$$z = 2.306 \text{ a. d. log.} \left(1+\frac{u^3}{10^3}\right)$$

The dependence that may be placed upon these expressions will appear from a comparison of the results they give, with those which are observed to occur in practice. For which purpose, we cite the following, as strictly in point, from the experimental practice at this place.

The target, placed in front of the battery of this department, is made of sound and seasoned white oak, well connected with wooden treenails and other fastenings, none being of iron except a few to bind up the extreme ends; the distance is 1299 yards.

In this were lodged one 32-pdr. shot and two 8-inch shells, fired from the U. S. long 32-pdr. (57 cwt.) and the 8-inch of 55 cwt.

The depths to which these projectiles entered, and those obtained by computation, compare thus:—

Class of Gun.	Chge. of Gun.	Projectile.	Penetration at 1300 yds. Computed.	Actual.
32-pdr. of 57 cwt.	9 lbs.	Shot	21 in. .13	21 in. .0
8-inch of 55 cwt.	7 lbs.	Shell	16 in. .16	15 in. .58

It is certainly no small merit to have approached so closely to the truth at nearly 1300 yards, from facts noted at less than 100 yards.

It was observed, however, that the earlier formula exhibited a tendency to represent the penetration in excess. Later results, obtained in France, induced a correction of this, and it will be observed that those obtained here indicate that this amendation might have been carried somewhat farther by the revised formula. The difference is, perhaps, of little practical importance, nor are the cases of penetration obtained here as numerous as might be wished for the purpose of additional correction: but they were executed with the utmost exactness, and have the advantage of determining the depth of perforation at a very much greater distance than any heretofore given of equal authenticity; thereby affording a wider basis for the computation, and very considerably reducing the extent to which it has been necessary to depart from this base, in order to estimate the value of distant penetrations.

For these reasons, I have preferred, in the following table, to amend slightly the empirical co-efficient,—using 2.2456 in lieu of 2.306.

PENETRATION

IN A MASS OF SEASONED WHITE OAK,

Of Shot and Shells fired from U. S. Navy Ordnance.

ORDNANCE.	Charge.	Projectile.	Initial Velocity.	Penetration in.			
				500 yards.	1000 yards.	1500 yards.	2000 yards.
	lbs.		Feet.	Inches.	Inches.	Inches.	Inches.
15-pdr. long	6	Shot.	1720	25.9	17.9	11.0	6.9
24-pdr. do.	8	do.	1720	33.5	21.3	14.1	9.3
32-pdr. of 32 cwt.	4½	do.	1250	26.4	15.5	12.7	8.5
32-pdr. of 42 cwt.	6	do.	1450	32.0	22.0	15.0	10.3
32-pdr. long.	9	do.	1700	38.7	26.5	18.2	12.5
42-pdr.	10½	do.	1620	41.7	29.7	21.1	15.1
64-pdr.	16	do.	1420	43.3	37.3	27.9	20 5
8-inch of 55 cwt.	7	Shell.	1350	29.2	20.2	14.0	9.7
8-inch of 63 cwt.	9	do.	1500	33.2	23.0	15.9	11.0
10-inch of 86 cwt.	10	do.	1160	32.1	24.2	18.2	13.7

The quantities thus assigned are to be considered as representing only the mean penetration of balls, in firing a series of them into a target; from these averages the individual results may be expected to depart more or less, proportionally to the care which is used, and the success attained, in avoiding the causes of these variations. These may be attributed to differences in the force of the projectiles upon striking the object, and to difference of resistance encountered by them respectively. Dissimilarity in weight

and size of ball,—in strength and action of the powder—in the texture of the material, &c., will all contribute in a greater or less degree, to the seemingly singular discrepancies of perforation which are noticeable, even in the best conducted experimental practice.

The great irregularities that exist in the constituent elements of projectile movement, make their influence, unfortunately, too sensible to the least observant spectator of gun practice. Among these may be reckoned,

1st. *Inaccuracy in size of Ball.*—This is limited as regards exterior dimension, by the regulation which forbids the reception of all shot or shells if they exceed or fall short of the given diameter more than two hundredths of an inch. So that two balls may differ from each other as much as four hundredths of an inch, but no more.

2d. *Inaccuracies of Weight,*—which in shot are due to variableness in the density of the metal itself, and to cavities that are produced in the casting of the shot, and therefore influence the general density of the projectile itself.

The limit imposed by regulation upon this error, has reference to deficiencies only, which must not extend beyond $\frac{1}{60}$th or $\frac{1}{160}$th of the weight of the ball, acccording to its calibre and kind.*

* Though it would be advisable to restrict it in the excess also, because this may arise from very hard iron, which is unsuitable, as well as from very dense iron, which is a good quality.

But in shells, the inexactness of weight is more likely to arise from errors in thickness, and to be considerably greater than in shot; so much so indeed, that it is very difficult to select a single series of shells of like weight, unless the lot be very large.

3d. *The propelling power* is liable to very palpable variations in its intensity, which will be observed, not only in the powder made by different establishments, but even in that made at one mill.

In 1854, a contract for navy powder was distributed among three manufactories. In the course of examination after delivery, the Ballistic Pendulum gave the following indications of strength:—

In. Velocity per second
No. 1. = 1613 feet.
" 2. = 1554 "
" 3. = 1546 "

The initial velocity of powder from barrels of one lot, made at the same mill, were:—

No. of barrel =	172	16	405	419	19	155	175
In. Velocity =	1538	1568	1573	1552	1562	1554	1531

The consequences of these variations in size and weight of ball, and force of powder, are developed upon the surface exposed to the action of the charge, and to the resistance of the air—the quantity of gases that escape over the ball when the charge is ignited—upon the capacity of

the ball to overcome the resistance it encounters, and the amount of velocity it receives.

Some of these are exhibited at the initial movement of the ball, being reduced during flight so as to become inconsiderable at collision with the object,—others are permanent and more marked in their influence.

With such dissimilarity in these elements, and in their combination, it follows that there must be corresponding differences in the projectile movement of shot and shells, and in the force with which they strike an object.

But the most influential cause of diversity in penetration obtained by experimental practice, will most probably be found in the unequal resistance of the substance struck by the balls: for differences in the texture of wood are almost unavoidable, arising either from inherent causes, or from the mode and extent of the seasoning process. So that between the inequalities of movement in the projectiles, and of the resistance they encounter, it is reasonable to expect considerable anomalies in the results of the best target practice: all that can probably be exacted is, that the variations due to these and other causes, shall be kept within the least practicable limits.

In proportion, however, to the extent of the variations, must the individual results be repeated, in order to reach a reliable mean. Such data can then be conveniently associated, and will furnish the means for comparing the perfora

tions made by projectiles of different calibres, and also of like calibre driven by different charges. The comparative value of ordnance will thus be ascertained with considerable precision, and we shall know how far one piece exceeds another in respect to penetration, and whether the excess amounts to a practical advantage or not.

The purpose then, of target practice, is merely to determine the *comparative* penetration of balls; and for this it is absolutely indispensable, in order to decide upon the power of ordnance that shall be used in armaments.

But the results thus obtained, by no means represent the penetration and effects of shot and shells on ships, because the latter differ so widely from the target in nature of material, and in character of the structure.

The one is intended to present a homogeneous mass of the same substance, while the material of the ship varies in its kind and in structure, being composed of different species of wood, such as white or live oak for the frame—white oak, or yellow pine for the planking: then there is a variety of iron and copper fastenings so distributed, that a shot can hardly miss one or more.

The character of the structure also produces great irregularities in the resistances to be encountered. In one place occur intervals between the frames; just by, the side is solidly made up of frame and plank; in another place are heavy knees, or the deck itself: while at bow and stern,

the massive assemblage of material is of prodigious strength. Moreover, the thicknesses of the side, from outer to inner surface, vary most materially, as will be seen by the following authentic dimensions of French ships:—

THICKNESSES.

Of the sides of French Ships of War, of all Rates.

(From the Aide Memoire Navale.)

CLASSES OF VESSELS.		THICKNESS, At lower port sills of				At	
		Spar deck.	Upper deck.	Main deck.	Lower deck.	Water line.	Orlop deck.
		in.	in.	in.	in.	in.	in.
Line of Battle Ships.	1st Rate	18.12	20.48	23.23	31.11	32.29	33.87
	2d "	18.12	.....	22.84	30.72	31.90	33.47
	3d "	17.33	.....	21.27	28.75	29.93	31.11
	4th "	17.33	.....	20.09	26.39	26.58	27.37
Frigates.	1st Class	16.93	.....	.....	23.63	24.81	25.60
	2d "	15.75	.....	.....	21.66	22.84	23.63
	3d "	14.57	.....	.....	18.51	20.09	21.27
Corvettes, (à gaillards)		13.39	.....	.....	16.54	16.93	18.90
Brigs of 20 guns		13.78	.....	.....	.....	13.78	15.75

With such variant capacity for resistance, it will be perceived that the effects of artillery upon ships must be exceedingly unequal, and altogether different from those produced by the same projectiles upon solid targets.

The following results from a well known authority, will serve to illustrate this view of the matter.

In the practice upon a hulk (*Prince George*, 1838) as given in his Naval Gunnery by Sir Howard Douglas, it is stated that:—

"Several 18-pdr. shot with charges of 6 lbs. of "powder, penetrated to depths varying from 21 "to 33 inches, according to the state of the "wood, and there stuck."—

—"With charges of 8 lbs., the 32-pdr. shot pene- "trated to depths varying from 22 to 48 "inches."—

—"The depth penetrated is expressed by the "sum of the distances in solid wood, which the "shot passed through or deeply furrowed."—

It is manifest at a glance, that the variations of projectile force are altogether inadequate to account for the excessive differences in penetration, and which consequently must be due to the unequal resistance of the substance pierced by the balls.

If the tables recording the results of experimental practice are consulted, it is found that they furnish little data for supposing that 18-pdr. shot would be capable of perforating a hull in this manner.

Thus at 1200 yards, the tables given by Sir Howard Douglas tell us that an 18-pdr. shot will enter about 15 inches into white oak. But when fired into the hulk of the *Prince George*, the same kind of balls perforated 21 inches at the least, and even so far as 33 inches in some cases.

The tables give about 19 inches as the penetra-

ting force of the 32-pdr. shot (6 lbs. of powder,) while they never entered less than 22 inches into the hulk, and sometimes as much as 48 inches.

The statements quoted do not leave us at liberty to suppose, that any part of the extent of the perforation was lacking in solidity; for it is said that, "the depth penetrated is expressed by "the sum of the distances in solid wood which "the shot passed through or deeply furrowed."

However, as the penetration is said to vary with the state of the wood, it is inferable that some of it was unsound, and hence the excessive perforations.

But it appears that in one instance, where the wood was *sound and solid*, a 32-pdr. shot entered 39 inches, and what is more singular, this was accomplished with a charge of 6 lbs of powder, when two other 32-pdr. shot, driven with charges of 8 lbs., penetrated only 22 inches and 25 inches.

There is no doubt that the discrepancies here noted, and others of like nature, have been much exaggerated by subjecting old hulls like this to practice, which are not only decayed, but by their construction, so much inferior in strength to modern built ships, as to furnish results which, so far from throwing light on the question, only confuse and obscure it.

Still there would be found, as already observed, very material differences between the penetration of projectiles into a solid target, and the structure of a ship, however sound its substance.

For the passage of a projectile *through* the wood is not always effected by the actual division of the substance. The concussion due to its momentum is frequently a powerful adjunct in accomplishing what the penetration alone could not have performed.

This is illustrated by a result that will be described subsequently, where it will be perceived that the actual division of the fibres by a large projectile was traceable for 20 inches, which, with an indentation on the remaining substance, somewhat less than an inch in depth, coincided nearly with the computed penetration —($20^{in.}.7$).

The timber not pierced by the ball was about 9 inches thick, and this was fairly broken asunder, leaving little doubt, in connection with other results of a similar nature upon the same target, that the entire transit of the shell through it could not have been accomplished wholly by the penetration.

Now, though we are not furnished with an account of the manner in which the material of the hulk (*Prince George*) was traversed by the shot fired, yet it is probable, that the incongruities just noted, may be explained in part by supposing that the path of one ball may have lain through a greater variety of parts not mutually sustained; and thus the projectiles had a more favorable opportunity for exerting its concussive power, by breaking through the farther surfaces,

than another ball whose force was expended on more solid material, and was limited in its course to mere penetration.

It is well, therefore, to remember, that the penetration of balls in a naval structure, as usually stated, includes the crushing out of the farther surfaces of planking, frames, &c., as well as the initial perforation by actual division of the substance; and its effects are generally experienced, in action, to be more destructive to the personal than that of shot.

Thus the probable effects of artillery on ships, require no little patience and ingenuity to resolve, even when the practice is conducted experimentally, and therefore with power to determine many of the conditions under which it shall occur: but in action, these are not only beyond control, but most frequently beyond conjecture, and the results are liable to the whole possible combination of effects, due to unequal force and to unequal resistance.

The penetration given in the tables, usually supposes the flight of the ball to be direct; whereas in action, a large number of shot ricochet, and are thus liable to a serious diminution of force in striking the object—varying with the condition of the water and the curve of the trajectory. It is true that this mode of practice is preferable to direct fire when the water is smooth, and the gun level or but slightly elevated; the ball then loses but little force, the

lateral deviations are inconsiderable, within effective range, and it sweeps closely to the surface of the water, rendering the practice more sure and much to be recommended. But when the surface is rough, the ball bounds high, on ricochet, and is also liable to be deflected from its direction, losing more or less force according to the resistance encountered at the reflecting surface, which can be approximately estimated by the elevation of the bound.

The same result is produced by increasing the elevation of the gun, which may be observed by the effect on the final roll of the shot; diminishing with every degree of elevation, until at 5° or6° it ceases, ordinarily, to rise at all from the water.

In general, direct firing, when the object is not near, implies the inapplicability of ricochet practice by reason of the unfavorable condition of the water; therefore, the accidental ricochet, under such circumstances, detracts more or less from the force of the ball.

Again, the penetration of the tables assumes the surface of the object to be placed rectangularly to the direction of the line of fire; while in actual combat this will be an unfrequent occurrence; for the opposing ships will be in constant motion in order to obtain or to preserve certain advantages of position, or to prevent the attainment of them by the other party, —tacking and wearing, shifting the course, forging ahead or dropping astern: consequently the

hulls, in the great majority of cases, will be presented more or less obliquely to the direction of fire, and the effort of the ball will be unfavorably exerted on the tough and elastic fibres of the oak, in proportion to the inclination of the surface with the direction of the ball's flight, and when this angle is reduced to 15°, the ball glances entirely.

This same cause increases the thickness of the material which shot are obliged to perforate, in order to pass through a ship's side, the least thickness being found along the line drawn perpendicularly through a given mass whose exterior and interior surfaces are parallel.

It may be observed that the invariable consequence of both these incidents to naval actions, is to lessen the force of the ball and to create a greater resistance to it. Wherefore, the fire of a battery from a ship while engaged, must ordinarily produce much less effect upon an opponent, than those assigned by experimental practice conducted in the usual manner upon hulks, supposing that in all else the conditions are similar and equal.

From this cursory view of the subject it will be perceived, that the general law of penetration by shot or by shells into homogeneous masses of white oak, and woods of similar toughness of fibre, is sufficiently well ascertained to supply all the necessary data for determining the capacity of different ordnance to overcome the resistance

of such materials: but, that the effect of artillery on ships-of-war can scarcely be estimated properly from any practice yet executed; as the hulls employed for the purpose have been so dissimilar in structure and inferior in material to those that are to be the objects of fire in naval actions, as to afford no means of judging at what distances the heavier calibres could be relied on as decisive. Indeed, one might be led astray in this respect, even as to the capacity of the cannon best known and commonly used,—for the practice on the *Prince George* would certainly lead to the belief that the 32-pdr. was capable of producing decisive results very much beyond what is well established to be its limit.

From this lack of proper information, the most conflicting opinions are current among professional men, and eminent authorities abroad disagree widely as to the fitness of certain classes of ordnance; some preferring the heavier calibres as more powerful, *while others are content with a lower calibre, because they deem it of sufficient capacity to be decisive at all practicable distances, and more convenient in use.*

We believe that the proper conclusion proceeds so plainly from the premises, as not to require absolute demonstration; but the fact that officers of great experience entertain different opinions, renders its full investigation indispensable.

Each proposed advance in naval calibre has been the subject of serious discussion and delay.

The 18-pdr. only gave way to the 24-pdr. after the events of battle had removed the doubts of the most sceptical—the impulse, however, was sufficient to carry us and others even to the long 32-pdr. for frigates, and long 42-pdrs. for line-of-battle-ships. But then its influence terminated, and for awhile there was a tendency to reaction, so far, that in the heaviest ships the long 42-pdrs. and 36-pdrs. gave way to 32-pdrs. and 30-pdrs.

We consider that the target practice is quite sufficient to decide which is the preferable gun in regard to accuracy and penetration; and we infer thence, that *the gun which has these qualities in the highest degree, is the most fit for naval purposes, so long as it is convenient of management.* Also, that its superiority extends to greater distances, in proportion to its greater accuracy and penetration.

The circumstances of action may so far diminish the accuracy of fire as to make a reduction of distance requisite in order to ensure a result within a reasonable time. But other calibres will be affected by like causes; so that whatever may be the effective distance of the heavier gun, whether 500 yards or 2000 yards, that of the lower calibre will be less.

It is of importance, therefore, to be able to form some idea of the distances where an effective fire can be maintained, and thus to judge of the general value of different batteries under the various circumstances of wind, weather, dis-

tance, &c., and the capacity of a ship's company to give it effect.

It would be very gratifying to be able to offer any material contribution to the much needed information in regard to penetration, but the means at disposal have not permitted this, beyond the few facts that are given in the following pages.

The target is of solid and sound white oak fairly seasoned. It is formed of three series of squared timber; the two outside layers placed horizontally, the middle series vertically,—each series measuring 10 inches through, making the total thickness of the target 30 inches. The timbers are well fastened together by treenails, and clamped by stout perpendicular battens at the ends, and in the middle, firmly bound together by iron bolts, which are the only metal fastenings in the target.

Its dimensions are, 30 feet long, 10 feet high, and 30 inches thick.

The distance from the Battery, ascertained by triangulation, is 1299 yards.

It stands in the river upon a firm foundation of stout logs, placed on the bottom of the stream.

On the top of the target are four upright poles to spread a screen of the same size as the target.

U. S. Navy 32-Pdr. of 57$^{cwt.}$

Charge, 9*lbs.* *Shot*, 32½*lbs.* *Elevation*, 2° 35′.

The shot took effect about 8½ feet above foot of target, and 5½ feet to the right of line of aim, drawn vertically on the middle of target.

On examination, the entrance of the shot into the wood was indicated by a circular indentation nearly equal to its size, within which the surface was crushed, and, towards the centre, broken into small fragments packed so closely into the narrow aperture, that it required some force to introduce the sounding wire as far as the shot.

The penetration was ascertained to be 21 inches. There was no appearance on the rear surface that the shock of the blow had injured the layer of timber not penetrated by the ball, and the wood immediately contiguous to the outer orifice presented no appearance of being split or injured by the entrance of the shot.

U. S. NAVY 8in. OF 55cwt. CHARGE, 7lbs.

Service Shells, (filled with Rice to make up weight of Powder charge,) 51½lbs. *Fuzes,* 15seconds.

Weather clear, wind light and gradually increasing to a moderate breeze—direction adverse—from left at about 45° to line of fire.

No. of Round.	Elevation.	Range.	From flash to 1st graze.
1	3°40′	Struck.	——
2	3°40′	1285	4.8 Passed to left of target.
3	3°45′	1377	5.2 { Cut off head of 2d screen pole, 20 feet above foot of target and 5 feet to left.
4	3°42½	1341	4.8 Passed to left of target.
5	do.	Struck.	——
6	do.	do.	——

Observations at Battery during the practice.

No. 1. No jet of water seen, nor other indications of effect of shell

No. 2. Missed—The jet of water was seen close to the left of target.

No. 3. The screen was seen to droop, but no perforation was perceptible, and the jet of water appeared behind the target.*

No. 4. Missed—jet seen to left of target.

No. 5. No jet—sound of the shell on striking heard distinctly,—the impression also visible near head of target.

No 6. Splashed the water slightly in front of target, but did not make a decided jet.

* The shell cut off the head of the second pole 20 feet above the water.

REMARKS.

No. 1.—The shell had entered at the juncture of two timbers, low down at the left corner of the target, about two feet above the water and 1½ feet from the end, or 13½ feet from the line of aim.

Its entrance was shown by the shattered condition of the surface, not exceeding in extent, however, the diameter of the projectile. From this spot issued some longitudinal fissures of one and two feet in length. At first, some force was necessary to insert the sounding wire, so as to feel the shell, which was not visible, the perforation being packed with small fragments; but these became loose in a few days and many fell out, so that a small portion of the projectile was to be seen.

On cutting out the shell, with the contiguous wood, it was found to have passed through the outer timber (10 inches) by dividing the fibres and violently forcing aside those which had been thus severed, leaving them to spring back and close behind it.

It had not perforated the second layer of timber, but had compressed the wood so as to make a bed or indent of about 3¼ inches in depth. The particular beam of this set which it struck, had been split with the grain to some extent in more than one place, and with a portion of the

rear layer which yielded to the blow, was forced back, so as to be separated from the front timbers for about 1½ inches.

No. 5,—struck at the junction of two timbers, about 2½ feet to left of line of aim, and 8½ feet above water.

Its penetration was 16½ inches, including the starting of the timbers by the blow, (about ½ an inch.)

The appearance of the orifice, and the condition of the perforation, were exactly similar to those of No. 1.

No. 6,—struck about 1½ feet to the right of line of aim, and 2½ feet above the water.

The entire penetration was 13½ inches, including the starting of the timber by the blow, (about ½ of an inch.)

The appearance of the orifice and perforation, resembled those of Nos. 1 and 5.

The diminished penetration was occasioned by the shell having first struck an upright timber, belonging to the foundation and standing in front some two feet above lower edge of target, —this was shivered to pieces as far as the surface of the water.

Notwithstanding the care taken to fasten the parts of the target firmly together, it will be perceived that the layers of timber were always separated more or less by the final effort of the concussion.

As there is no doubt that the thickness of

wood penetrated by the shell, would have been greater if the timbers had not yielded and separated, some increase of the actual measurement of perforation is proper. What this should be, it is difficult to say; but from other results it is probable, that the distance from the exterior surface to the bed of the shell is not far from the truth. The penetration of No. 6 is rejected, because of striking the pile in front.

Condition of projectiles, &c.

The shells were such as are commonly used in the United States Navy, and had an excentric mass about the fuze-hole, placed in the gun as usual; that is, in the plane of projection and upwards, about 45° from the vertical.

No. 1—was found with its mass in the plane of projection, but downwards and outwards, about 20° from the vertical.

No. 5—had the axis of the excentric mass horizontal, and directly in front.

No. 6—had the axis of the mass horizontal, and directly to the rear.

The metal fuze stocks of Nos. 1 and 6, were readily unscrewed; but that of No. 5 had sustained more pressure, and rather more on one side of its face than the other: wherefore, some force was needed with the wrench to start the

stock at first; but once turned, there was no farther difficulty.

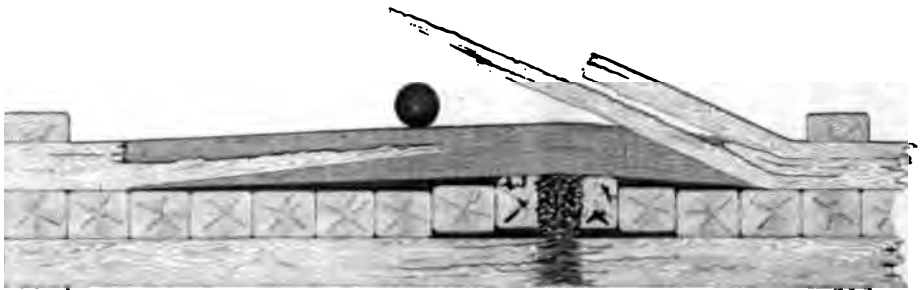
The operation of all the apparatus appeared regular and satisfactory; the combustion of the composition was complete, as shown by the charred surface of the material in contact with it, and by other indications; leaving no doubt that the shell would have exploded, had it been charged with powder in lieu of rice.

The severity of the test to which the fuze of No. 5 was exposed, is worthy of particular note. As already stated, the shell was found embedded in the wood, with the fuze directly to the front, and it must have received the full force of the impact. The metal stock was not, however, materially disturbed by this enormous shock; the fibre of the wood had been forced into every recess and aperture on the face of the stock, and packed there so firmly as to resemble a solid mass, only removable by a sharp steel point. In so doing, the fibre came out in the most attenuated threads. The gas from the burning composition seems to have effected its way through this obstacle, for immediately around a small orifice in the woody mass was deposited a whitish residuum, (sulphate of potash.)

There was not the least evidence that the final concussion of the shells had done injury to the substance of the target in front of, and unpierced by them.

Penetration in Oak Target
at 1300 yards.

Shot from 32 pdr of 57



Perforation by an unloaded Shell

New U. S. Navy Shell-gun for Broadside.

Shells, (filled with rice to make up weight of powder charge,) Concentric and plugged—no Fuzes.

Very light airs—water smooth.

No.	Range.	Remarks
1.	——	Struck direct.
2.	——	Ricochetted over.
3.	1326	Grazed edge of target.
4.	1286	Struck on ricochet.
5.	1296	Struck on ricochet.

No. 1,—struck direct, 5 feet to the left of the middle line, (or line of fire,) and about 7¾ feet above the foot of target. It pierced the first and second series of timber, each 10 inches thick, and broke asunder the rearmost timber just at the place of impact, forcing the right end outwards 16 or 18 inches,—the other part, being sustained by the rear brace, was not moved; but its outermost half was split off, making a large splinter, six feet long, which was driven at least 20 yards.

The shell dropped down and lodged on some plank placed behind the target.*

No. 2,—fell 49 yards short, and, by means of a glass, I saw it pass over the top of the target—the screen was not spread.

No. 3,—struck direct, 5½ feet above foot of target, grazing the right edge, so as to score

* Upon close examination, its shape was found to be unaltered.

the timber-ends with about half of its diameter With the glass, I saw the shell and the splinters that flew off. The shell struck the water 27 yards beyond the target, and bounded 70 yards further, when it sank.

No. 4,—fell about 55 yards short, and rising from the water, struck the left side of the target 7½ feet from the middle line and four feet above the foot; it penetrated 14 inches.

No. 5,—fell short 3 yards, and, in rising from the water, lodged in the right face of the target about 10 inches above its foot; it penetrated 16 inches.

The first shell struck at the junction of two layers, the lower of which included most of its diameter,—it then passed through one of the second series, perforating it completely and starting it, with an adjoining timber on each side, from the first series, making a separation of one or two inches; having descended with the course of the trajectory, it encountered a single rear timber, indenting it slightly and breaking it out as already described.

The external appearance of the orifice made by this shell, resembled those of the 8$^{in.}$ shells already described; being closed by the resilient fibres and small closely packed fragments detached from them.

The effect of ricochet, at the distance of 1200 or 1300 yards, upon a projectile of this size, is exhibited upon the two subsequent shells,—the

force of impact being thereby so much impaired, as to diminish the penetration one-third and one-fifth. Hence, there was not only a greater unperforated thickness to resist the shock, but the shock itself was also lessened.

And yet, notwithstanding these unfavorable circumstances, the power of the concussion was manifested by the transverse cracking of the timbers that arrested the shells, which was visible on their outer and farther surface directly before the ball. So that, while the 32-pdr. shot, with a higher remaining velocity, was unable to produce any perceptible effect on the 9 or 10 inches of timber in front of it, the larger shells broke through an equal thickness, and even when their velocity had been diminished by ricochet, were able to fracture, though not to force aside, 14 to 16 inches of the same material. The 8$^{in.}$ shells, however, though larger than the 32-pdr. shot, could not effect a like result.

Hence it appears, that the capacity for superior penetration does not always represent the powers of different calibres,—the effects of volume and remaining momentum in approaching the limit of penetration, are to be taken into consideration.

The breaking out of further surfaces cannot fail to exercise the greatest influence when naval structures are the objects of fire,—as the resistance of a much greater amount of material may thus be overcome, and with very disastrous effects to the personal. Of course the aggregate thick

nesses of wood traversed by the ball, do not then express the penetrating power of the shot, but will generally exceed it; and to this, probably, is owing the anomalies already noted between the results of practice upon ships and upon the solid wood of targets.

The operation of the first shell embodies a rare illustration of the effect, which has been so often defined as the greatest derivable from any given projectile: that is, the force was *just sufficient to take it through the substance*, and was then so absolutely expended, that the shell rolled down the rear surface of the target.

Had the target been composed of a number of small parts, like the side of a ship, instead of heavy masses of solid oak, it may readily be conceived that the quantity of splinters dispersed in every direction would have been very destructive.

When we reflect that the chief damage from shot to the personal of a ship is produced by this splintering of the interior surfaces; that the absolute penetration of the ball is required to produce any splinters at all; and, even then, that the quantity and size of the fragments depend so much on the character of the material,—we are naturally led to the idea of increasing the stoutness of naval structures as far as may be compatible with other requirements,—so that the penetration of shot may be avoided as far as possible; or when it occurs, the effects may be lessened by the use of the softer and less fibrous

materials for inner lining, through which balls make a clean perforation without detaching many fragments instead of the woods, whose tough and hard fibres produce the greatest amount and size of these destructive agents.

The value of a stout side and suitable material, cannot be too highly appreciated; and, judging from the dimensions just referred to, the French ships seem to be well provided in one of these respects. Our own builders should not lose sight of the matter.

It may be observed, in concluding this part of the subject, that when a shell lodges, its explosive effect *is not independent of the penetration*, but is determined by its extent; while on the contrary, if the shot remains in the wood, it is harmless. If the shell, however pass through the object, it will do it no less damage than a shot, and may cause further mischief inboard by explosion.

VI.

SHOT AND SHELLS COMPARED.

Difference in the operation of Shot and Shells—illustrated by incidents of battle and of experimental practice.—Introduction and progress of Shell-guns in the Naval service.—Discrepant opinions regarding the extent to which it is proper to adopt the shell system on ship-board.—View of the question between shot and shells of like weight; illustrated by a case from practice.—Opinions of authorities.—Shot and Shell-guns in service compared; uncharged shells not to be used.—Long 32-pdr. and 8-in. of 63$^{cwt.}$; respective accuracy, penetration and power.—Canon Obusier, of 22$^{cwt.}$—Pivot-guns; 10-in. of 86$^{cwt.}$ unsuitable.

THERE is no similarity in the action which shot and shells are designed to exert on timber.

The shot is to pierce and separate the wood by the force of penetration alone, crushing and rending the fibres, tearing asunder the several parts bolted together, and driving off splinters large and small with great violence from the further surface.

The shell is intended to explode while lodged in the mass of the ship, disuniting its structure, and driving out more or less of the material in fragments.

The perforation made in wood by shot varies with the nature of the wood, its thickness, mode of combination, the size and velocity of projectile, &c.

In masses of the tough and seasoned substance

of white oak, such as used in large ships-of-war, the orifice is commonly very much less than the shot,—for the fibres of the wood yield momentarily to the projectile, and spring back, leaving a fissure of no great size, around which the exterior texture of the wood appears to be bruised and crushed to an extent very little larger than the diameter of the shot,—and the comminuted particles of wood are found to be packed so firmly into the fissure that, when the shot lodges, its course is only to be traced by a wire of moderate thickness.

The greater damage to the timber is seen on the furthest surface where the shot has its egress. This is much shattered and splintered, with fearful effects to the men—the dimensions of the fragments depending on the size and velocity of the shot. The effect is generally recognized to be greatest where the force of the shot is but little more than sufficient to pass through, as already exemplified in the course of these remarks.*

But if the shot does not perforate entirely, it is plain that it will injure neither material nor men. And this frequently happens, in the course of naval encounters, from the great diminution that occurs in the force of the shot and the increased resistance of the object; the velocity of the former being liable to rapid abatement from

* See "Penetration," page 200.

the opposition of the atmosphere, or collision with the water, so as to be deprived of a fourth, a third, or even a half of its initial velocity at moderate distances; while the nature of the resistance and its extent are much augmented by the oblique presentation of the surface struck.

The operation of shot is also liable to further limitation, even when the ship is pierced at the water-line or below it; for the entrance of the water is so far prevented by the smallness of the orifice and the particles of wood which fill it, that full opportunity is generally afforded to remedy the evil and counteract the damage by plugging the hole.

Considering then how many shot would be unable to pierce the object, or fail of full effect at a vital part; and that very many do not strike at all, it may well be supposed that a great number of shot would be required to sink a large and well built ship-of-war, and that as a general rule, the surrender would oftener be effected by the destruction of men, masts, spars, gun-carriages, &c.

Certainly it is only in this way that the duration of actions, and the disproportioned effect on ships of protracted firing with heavy cannon, can be explained. It is of rare occurrence that large frigates or line-of-battle ships have been sunk even in the most desperate encounters,—and the amount of battering which such vessels

have endured from 18-pdrs., 24-pdrs., and even 32-pdrs., is surprising and almost incredible.

At Trafalgar, this remark was more than usually well illustrated; because of the great number of ships engaged, their close approach,—for they frequently touched each other,—at times the combination of several ships upon one, and the smoothness of the water which, unruffled by wind, was only affected by a long undulating swell. The ship of Lord Nelson, in bearing down, received a few single shot at about three-fourths of a mile from the French line,* and, in leading the weather column, presented a prominent mark to the enemy. As she slowly approached at a rate not exceeding a knot and a half per hour, the firing increased, and when about 500 or 600 yards from the combined fleet, it is stated that 200 pieces of heavy artillery were playing upon her unanswered.† In this manner forty minutes elapsed between the firing of the first shot and the passage of the *Victory* close under the stern of the *Bucentaur*, at which instant Nelson's battery was opened,—the first broadside being delivered when the ships were nearly touching,—and it is said to have made the *Bucentaur* heel two or three strakes.‡ The

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* *Allen, De la Graviére, &c.*

† *De la Graviére.*

‡ *Allen.* The same effect is said to have been noticed when the Spanish ship *Santa Anna* fired into the *Royal Sovereign.*—(*Life of Collingwood*, 178.)

other ships of the English line, ranging in the wake of their leaders, received and returned entire discharges of the batteries in like manner. In this way for three hours was the contest maintained; and many cases occurred where single ships were exposed for a considerable while to the fire of several. Thus the *Belleisle* is said to have been assailed for at least an hour by three French ships, *Achille*, *Aigle* and *Neptune*. The conflict was almost in the style of a general *melée*, and in it were mingled 60 of the largest ships in the world, engaged from one till four o'clock in furious strife, delivering their broadsides at distances so short, and at marks so large, that very few shot ought to have missed; and yet, not a single ship was sunk in the action,* and though horribly battered, but one went down in the gale that ensued about 36 hours afterwards.

In the battle of 1st June, 1794, Captain Collingwood (afterwards Admiral) states in a letter to a friend, that "the ship we were to engage "was two a-head of the French Admiral, so that "we had to go through his fire and that of two "ships next him, and received all their broad-"sides two or three times before we fired a gun." • • "We got very near, and then began such a "fire—" • • "We left off in admirable good

* *Simmons* asserts this of every battle during the whole war. (Page 70.)

"plight, having sustained less loss than could be "expected, considering the fire we had so long "on us. We had nine men killed, and twenty-"two with severe wounds, a few others slightly "hurt; our masts, &c., all in their places, though "much wounded." * * —"and this, altogether, "has been the hardest action that has been "fought in our time, or perhaps ever. It did "not last very severely much more than two "hours," &c.*

Another instance may be cited, in this connection, that occurred a few years previously to the battle of Trafalgar, and the number of shot expended by one vessel has been stated. In 1800, the French line-of-battle ship, *Gillaume Tell*, was attacked by the British ships, *Foudroyant*, 74, the *Lion*, 64, and *Penelope* frigate. The *Foudroyant* ranged up alongside about six o'clock in the morning, approaching the French ship so closely that her spare anchor just escaped catching in the mizzen rigging of the *Gillaume Tell*. The action was continued closely until 8h. 20′, A. M., when the *Gillaume Tell* struck; it is stated that the *Foudroyant* expended:—

1200 32-pdr. shot,
1240 24-pdr. shot,
118 18-pdr. shot,
200 12-pdr. shot,—

being a total of 2758† shot fired at a very short

* Life of Collingwood, pp. 29—31. † Charnock's Life of Nelson.

distance, besides those discharged from the batteries of the *Lion* and the *Penelope*. Yet the *Gillaume Tell* was not sunk, nor so much injured as to be incapable of service soon afterwards in the British Navy.*

In 1827, a combined Fleet of English, French, and Russian ships, anchored alongside a line of Turkish and Egyptian ships, and *as a consequence under the circumstances*, a battle ensued. Some of the incidents led to a court martial upon one of the English Captains, in the course of which, some evidence was given that is of interest to the present question.

Captain Smith deposed that, "the *Genoa*, 74, of "which ship he was 1st Lieutenant, was brought "parallel and her whole starboard broadside bore "on her opponent with complete effect. She "did not diverge from this position for above two "hours. They were close to the enemy, the "whites of whose eyes they could see as plainly "as he could see those of the honorable Court."

— "The *Genoa* continued in action with the "Turk *about three hours and a half; she did not* "*diverge from the parallel position for above two* "*hours*. By the evidence before the court mar- "tial, it appears that the *Genoa* expended 7089lbs. "of powder, and the *Albion* 11092lbs. It is "asserted that the *Albion* expended 52 tons of "round shot; if the expenditure of the *Genoa*

* Charnock's Life of Nelson.

"was in the same proportion, she must have dis-
"charged more than 30 tons of round shot;
"enough to open 65 feet of breach in the ram-
"parts of Badajoz, at a range of six or seven
"hundred yards." (*Simmons.*)

This battle, it must be remembered, was fought under circumstances most favorable to deliberation, accuracy, and effect—the combined fleet was permitted undisturbed to take its position close to the Turkish line; the water was smooth, and the ships were anchored, so that there was ample time and opportunity for preparation; the men at the guns were undisturbed by manœuvres of any kind; the distance within point blank, and the marks large;—the practice of an experimental battery should not have been better; and yet, by the quotations of Captain Simmons from the evidence given before a court martial, it is obvious that the operation of the shot was as usual only made decisive by the use of an immense number of them. Captain Simmons says, "the *Genoa* must have discharged 30 tons of "iron," which would make at least 2000 shot, if they are assumed to average 32lbs.

The prime purpose of the shell, as already stated, is to lodge and explode in the object, such as the side or contiguous material of the ship,—the lower masts,—or in the magazine, shell-room, or steam machinery.

The structure of vessels is known to be far more seriously damaged in this way than by the

penetration of shot; for instead of the imperfect and nearly closed orifice of the shot, a large quantity of timber is blown out from the surface, or if the shell is of considerable size, and its lodgment fairly effected in the side, it may blow the side through and produce a breach in it of some size.

The following cases of such effect are cited from the well-known experiments executed in France some 30 years since, by order of the French government, in order to test the alleged effects of the shell system of General Paixhans. They afford a fair idea of the consequences produced by shells properly embedded in a ship's side.

The practice was made on the *Pacificateur*, an old 80 gun ship, in the presence of a number of intelligent naval officers and savans:—

—"With the charges of 4½lbs, and at the "same distance (640 yards) a shell lodged in "the side between two ports and burst there, "tearing asunder the frames, the outer and "inner planking, and making a breach several "feet in height and width, so shattered, that "those present all thought the injury would "have endangered the vessel had it occurred "near the water-line."

(54)—"At 850 yards," the procés verbal says, "a shell struck the ship about 3 feet above the "water and its explosion forced out a plank "end, making an opening nearly three feet

"square. Moreover, two strakes of plank below "this hole and one strake above it, were, for "20 feet, started and separated from the frame "more than 5 inches at the place of explosion, "and more than 2 inches near the scarfs,—a "like injury at the water-line would have caused "the instant sinking of the ship."—

—"At 1280 yards, a shell entered the side "and burst there, breaking two of the ship's "frames, the clamps, two outer and two inner "planks, leaving a large hole of more than two "superficial feet.—The knee of the nearest beam "was broken into three pieces, one of which "was thrown to the middle of the ship."—

(55)—"A bomb fired at 1070 yards, after "striking the water, lodged in the hull between "two of the lower deck ports; its explosion "drove out an entire plank from port to port, "two-thirds of a second, started a third plank "along its whole length and broke part of a "perfectly sound frame; taking effect also with- "in, it displaced three ends of inner planks, and "the gun-bolts and rings of the next port."—

These represent the greatest effect upon a ship which a shell can exert by its explosion, having been so embedded as to encounter a resistance nearly equal on all sides; wherefore, the explosion acting in every direction drove out the timber laterally and inwardly as well as outwardly, so as to breach the side entirely through.

But we must be careful not to fall into the grievous error of supposing, that these examples illustrate the ordinary operation of shells—far from it:—they are instances of *maximum* or *possible* effect, even in the course of well conducted experiments, and are to be expected only in the ratio due to a given number of shells fired under like circumstances. *It is by the presentation of similar occasional results, instead of the general effect, that the value of particular projects is exaggerated far beyond their proper standard, and a fictitious reputation acquired* which melts away before the severe tests of actual service, to the disappointment of all who have been thus deluded.

The advantages of shells over shot, where ships are concerned, is sufficiently great to need no more than a fair statement.

In proportion as the shell fails to imbed itself where its action will be greatest upon the material it enters, *so will the effect be diminished.* For the explosion then takes the direction where the resistance is least, which, if the penetration is less than it should be, will always be found towards the orifice made by the passage of the shell, forming a kind of crater, the bottom of which is the bed of the shell. An instance of an explosion of this kind is noted at page 226, as having occurred in the practice at the Experimental Battery; the penetration was not quite sufficient to permit the shell to breach the target

through, but as the content of powder was larger, it was adequate to a decisive effect, if the object had been a ship; for the whole structure was violently shaken, and the rear timbers, not blown off, were forced asunder several inches, so as to open fair passage to the water.

As the penetration decreases, the explosive action of the shell is still farther diminished, so that when it merely enters no farther than necessary to its remaining in the wood, the effect must be superficial. Hence, *the explosive power of projectiles is not independent of their penetration.* The liability to diminished penetration increases necessarily with the distance or with other circumstances that may be unfavorable to the impact,—even when the force would otherwise be sufficient,—such as the obliquity of the surface struck, &c.

Again, if the shell pass entirely through the nearest side of the ship, it will operate upon it precisely as a shot would. The explosion may then occur subsequently after lodgment in the opposite side, in which case the action will be according to the penetration as already described, breaching the side or merely blowing inward; or the explosion may take place in the open quarters of the ship among the men,—or, even more disastrously, below amidst the steam machinery, or magazines. Liability to such consequences will of course occur at the

shorter distances, when the velocity of the shell has not been materially reduced.

But the common apprehension in regard to the utter failure of the explosive effect, by reason of perforating both sides before the fuze can act, appears to be more imaginary than real, especially when the huge masses of heavy ships are the object of fire.

The earlier practice rather contemplated the association of the shell with the shot in developing the power of Naval Batteries; and it was natural that the agency of a well tried means of offense, should not yield too readily to an innovation which, however promising in the hands of the experimenter, had not yet been subjected to the sure test of battle.

But it is now 30 years since shells have been admitted on shipboard as part of the established naval armament.

In discussing this question it may be premised, that all reasoning necessarily falls short of absolute demonstration, from the want of sufficient data. It has also been much complicated by existing circumstances,—for most nations have felt the necessity of turning to some account the enormous stock of ordnance and ordnance stores which have accumulated from time to time, and thus lessening measurably the immense expense

entailed by changes of any description. This consideration must always exert a great influence where the quantity of cannon in service is very large, because the expense of changes is then exceedingly burdensome. Thus when it was decided to reorganize the British naval armament, in 1839, it was stated in evidence to a committee of the House of Commons, that, as a consequence of this measure, 11,413 cannon and carronades were rendered obsolete; to supply the place of which, only in part, an expenditure of more than one million of dollars had been incurred.*

It is preferable, however, to divest the subject of this and all other extraneous elements arising out of the nature of existing armaments or calibres; inasmuch as they have been predetermined by considerations entirely foreign to the present inquiry, and must therefore lead to conclusions more or less erroneous.

In 1824, the ability and perseverance with which Colonel Paixhans had, through a series of years, devoted himself to systematizing and improving the *Nouvelle Arme*, was rewarded by witnessing its introduction into the French navy at the recommendation of a board of officers appointed by the government.

This measure did not fail to attract the attention of the British government to the subject,

* £239,000.

and extensive trials were made to test the new weapon and its most advisable adaptation to sea-service. Shell-guns were soon found in many or most of their ships.

In 1837, the French, by general regulation, established the shell-gun as an element of all naval batteries, and, in 1839, the English government did likewise.

The one being a consequence of the other, as since admitted in official documents—a report of a committee to Parliament, in 1849, says:—"Your committee inquired into the cir-"cumstances which led to the adoption of this "new arrangement, and they have been informed "that the change was not introduced into the "British service *until it had been adopted by* "*foreign powers*," &c. &c.

In 1848, a new order added largely to the proportion of shell-guns in the French service, and it found its corresponding movement in the rival navy,—not, in this instance, by a similar regulation, but by special orders of the Admiralty given from time to time for one ship or another; so that, in 1849, as many as 76 ships had been or were to be (according to official documents*) armed with an increased number of shell-guns. Some vessels had an entire tier of them (*Prince Regent*, 92, &c.); in others they constituted the predominating force (*Eurotas*, *Euryalus*, *Ajax*,

* See "*Composition of Batteries.*"

Emerald, &c.) The extent of these exceptional cases will be appreciated from the fact, that the seventy-six ships alluded to, carry 3995 cannon, of which 1235 are pivot and shell-guns; while the whole navy of the United States, building and built, would number only about 2000 cannon.

In 1841 a small number of 8-in, of 63$^{cwt.}$ were introduced into the U. S. Navy, and in 1845, when the armament of the service underwent an entire change by the introduction of the 32-pdr. unit calibre, the number of shell-guns was increased, and a lighter class of 8-in. shell-guns (of 55$^{cwt.}$) adopted for the spar-decks of Frigates and second class Sloops-of-war.

In 1853, the light shell-guns were removed from all spar-decks of Frigates and Ships-of-the-line, in lieu of which every gun-deck battery was ordered to receive an entire division of ten shell-guns (8-in. of 63$^{cwt.}$).

It will be perceived from this brief statement that, since the introduction of shell-guns, their number afloat has gone on steadily increasing; the early prejudice of the majority has yielded gradually to a better acquaintance with the projectile,—the apprehensions of danger to those making a common use of them, have failed to be realized,—ships, men, and officers are as safe from terrible catastrophes as they have ever been,—common consent and practice admits the great power of the new weapon, and a vessel

is not deemed to be completely armed which is without some shell-guns in her battery.

But it is evident from the practice of the principal navies, that while the necessity of shells is admitted, great variety of opinion exists as to the extent to which it is proper or expedient to rely on pieces designed solely for the use of such projectiles. So discrepant indeed is the manner of infusing the new element into naval armaments, that it cannot fail to create a very natural impression, that some err in exceeding, or that others err in falling short of the proper mark.

There must be a limit to the number of shell-guns in a ship's battery, if shells are only suited to particular exigencies. If, on the other hand, they are generally useful for all purposes legitimately naval, then is the number of shell-guns too few, the policy erroneous, that would restrict the development of this weapon to the performance of a subordinate part.

This, indisputably, constitutes the most important question of the day in relation to marine ordnance; and upon no navy is this inquiry, and a correct decision, more pressingly enjoined than our own. For it is only by a precise adaptation of all parts, and by special excellence, that the navy of the United States can compensate in anywise for the great disproportion of its numbers to the end for which it was created, and

has been maintained. The overwhelming fleets which such navies as those of England and France can put forth, will always suffice to avoid the evils due the weakness of individual ships. The navy of the United States, if not superior in numbers, *must needs be superior in all else.*

Having already attempted to convey some idea of the generic difference between the action of shot and shells, it is well to ascertain as far as practicable, the relative value of the effect of each under like circumstances, by such a statement of the chief points as can be derived from the data at disposal.

Supposing, then, that a piece of ordnance is to be constructed from a *given quantity of iron* capable of discharging a projectile of a certain weight, the question is to determine whether the projectile shall be a solid shot, or a shell.

For the sake of illustration, let the weight of projectile be assumed as 51 lbs.,—the diameter, if a shot, would be $7^{in}.24$,—if a shell, $7^{in}.85$,—let the initial velocities due to the charge adapted to weight of gun, be about 1475 feet, and the quantity of powder contained by the shell = 2 lbs.

The values of the shot and of the shell are to be decided by the respective *accuracy and power at equal distances.*

ACCURACY.

The shot and the shell have equal weights and equal initial velocities—therefore equal capacity to overcome the resistance of the air; but the shell presents a greater surface to this resistance —therefore its velocity is impeded in a greater degree, and more elevation is necessary in order to have the shell attain the same object as the solid shot of like weight. The curve of the trajectory is increased proportionally with the elevation, and the angle at which a ball reaches the side of a ship or other vertical object, being also greater or less according to the elevation, the probabilities of striking the given surface are diminished with the greater inflection of the trajectory.

On this account then, the 51 lbs. shell is inferior to the 51 lbs. shot in accuracy, as it requires a greater elevation to attain a given object.

The disturbing influences of the atmosphere are also exerted with more effect upon the projectile of an inferior density, so that its irregularities of motion are much increased; and here is another source of inferior precision on the part of the shell.

Hence, the lack of density operates as a twofold cause in rendering the accuracy of a shell inferior to that of a shot, the weight and initial velocity of the two being equal.

POWER.

This term is here intended to mean the collective results produced by:—

—The depth to which the projectile enters into the substance,—

—The superficial dimension of the orifice,—

—The extent beyond it to which the wood is rent, shattered, and splintered,—

—And the effect of the shock upon the remaining material by which its progress is finally arrested.

The penetration of the shell is necessarily less than that of the shot, because it arrives at the object with an inferior velocity and momentum, —it also encounters greater resistance from the wood in the ratio of its greater surface.

Using the formulas already cited at pages 176 –177 to determine the effect of resistance experienced by the projectiles, and their penetration in a mass of sound white oak, we shall have:—

	Initial	At 500 yards.		1000 yards.		1500 yards.		2000 yards.	
	velocity. Feet.	Veloc. Feet.	Pene. Ins.	Veloc Feet.	Pene. Ins.	Veloc. Feet.	Pene. Ins.	Veloc. Feet.	Pene. Ins.
51 lbs. shot,.....	1500	1173	41.1	940	29.9	767	21.7	634	15 8
51 lbs. shell,.....	.....	1130	33.2	879	23.0	699	15.9	565	11.0

The dimensions of orifice made by the shell and shot, are 48 and 41 square inches respec-

tively, giving the former the advantage of superficial limits.

Next for consideration is, "The extent beyond "the orifice to which the wood is rent, shattered, "and splintered," by the action of each projectile.

This, it will be perceived, from the very nature of the circumstances, cannot be reached with exactness, even when a solid mass of wood is the object of practice.

Still, the difference of effect due to impact and explosion, is sufficiently marked to enable one to form a tolerably correct idea of the consequences that may be expected to result from their employment against ships or other massive wooden structures.

An attempt has already been made to describe these effects, aided by the citations from the printed report of the first practice, ordered in 1824 by the French government, upon an old line-of-battle ship at the instance of Colonel Paixhans. It would have been very desirable to assist the judgment further, by detailed statements in regard to the shot fired simultaneously with these shells, and by sketches illustrating the appearance of the holes and rents made upon the sides and masts of the ship, both by shot and shells: but the Commission seem to have considered the question so fully settled by what was seen and stated in regard to the effects of the *new weapon*, as to abstain from saying more of the shot than, as their "effects are known and their inferiority

" was evident, only three shot of 36 were " fired."—(41)

—" As to the effect of ordinary solid shot, it " was not thought necessary to submit them again " to a comparison with shells and bombs." (56)

In the absence of this information, which would have been of the highest interest, the following instance from the practice on a solid target, (Experimental Department at Washington) may be used to exemplify the effects of impact and explosion by projectiles of like weight.

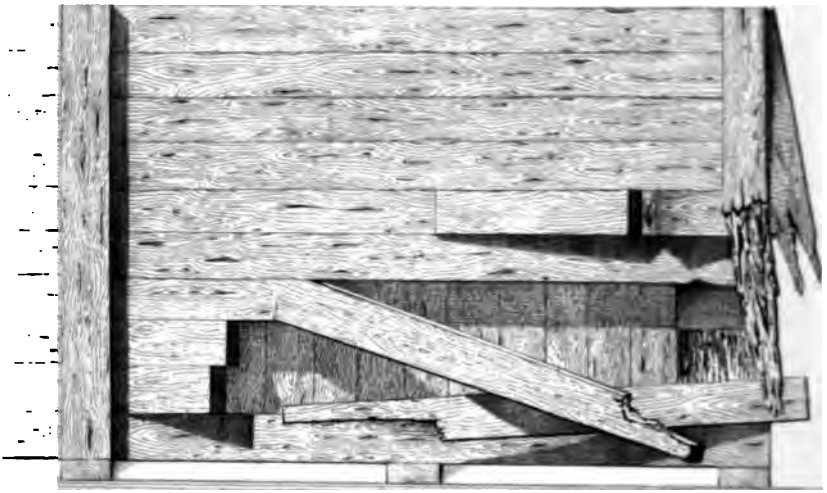
It is not strictly a case in point, for the projectiles used were larger than those assumed in the present statement; and though this circumstance might not influence the relation existing between the modes of action produced by shot and shells of like weights, there were other differences which would have that effect, though in no material degree and not difficult of estimation.

While firing IX^{inch} shells at a steamer moored about 550 yards distant, one of them passed through the very light upper works of the vessel and, bounding several times on the water, lodged in the target (white oak, 30 inches thick) distant 1300 yards; the explosion followed almost instantly,—On examination, the shell appeared to have entered about 20 inches into sound wood on the extreme right, and the explosion, radiating from its bed, which was very distinctly indicated, forced out and broke off three outer tim-

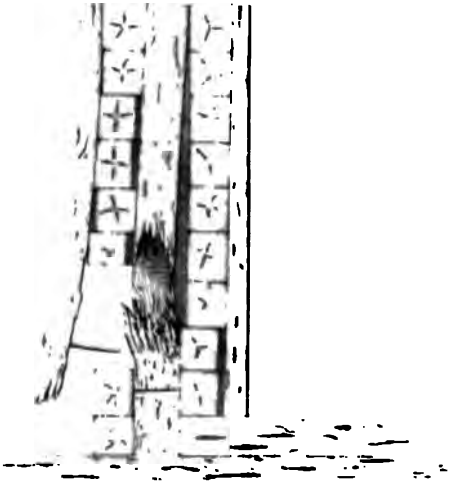
Explosion of a heavy Shell in Oak Target

Sept 1852

Front View



Plan View



bers 12$^{ins.}$ by 10$^{ins.}$ square, and shattered the middle timbers laterally,—in all, about twenty-seven cubic feet of sound wood were displaced. The thickness of wood unpenetrated by the shell, was about ten inches through; this, though not rent or broken, was forced forward with the timber above and below, so as to leave a space of some inches between these timbers and the others.

A shell of like calibre, but unloaded, was fired at the same target; it penetrated the timber about 20 inches, and breaking asunder the remaining wood, passed entirely through the target, throwing off to the distance of 20 yards a splinter 6 feet long and 6 inches thick.

The annexed sketch, made on the spot, exhibits the effect of the explosion—that of the perforation has already been given at page 199.

It will be remarked, that the force of the impact would have been greater if the iron in the unloaded shell had been made into a solid shot; as its reduced volume would then have met with less resistance in traversing any medium. But nothing was lost to the effect of the projectile on this account; because it had force enough to produce the *maximum effect which it was capable of by impact alone*: that is, it had sufficient momentum to make its way through the target and no more. If it had had the greater penetrative power due to its weight in a solid sphere, its division of the wood by perforation would have

been increased, and the remaining thickness broken through by the shock, decreased; hence the shattering and splintering on the further surface where the ball passed out, would have been much less than it was.

On the other hand, the effect of the explosion is represented to be less than it ought to have been,—because the penetration of the shell was diminished by passing through the light bulwarks and hatch-coamings of the steamer, as well as by striking the water on ricochet; therefore the explosive effort was more powerfully resisted by the greater remaining thickness of wood unperforated, and its capacity lessened to blow through in that direction.

It will also be remarked, that the shell struck close to the end of the target, which was therefore the centre of explosion, and there remained to it but one direction where its effect could be manifested,—to the right, the effort was expended on the air. Had the shell struck the middle of the target, so that the explosion might have operated each way on the timber, the quantity of wood shattered and blown off, would have been very much greater than it was.

Wherefore, as the effect of the impact is here exhibited at its maximum, while that of the explosion was diminished by accident, and, is consequently inadequately represented, it cannot be objected to the use of this case that its results

exaggerate the *relative power of the shell when compared with that of a shot of like weight.*

Recapitulating the several points noted, it appears, in regard to shot and shells of like weight, that:—

The shot has greater precision, which is an admitted advantage,—

The shot has also greater penetration,—but the shell does not require this property to the same extent as the shot, because the latter must always perforate the side entirely to operate with effect,—while the action of the shell will be materially lessened in its explosive power, if it does pass through instead of lodging.

Hence, it may be assumed that the penetration of the shell is adequate to its special purpose at any distance where shot of like weight are effective; that is, if the shot pass entirely through, the shell may do so likewise, and explode inboard: or it may lodge and work great destruction to the side. It has the farther advantage of acting in a greater or less degree at distances where the shot is incapable of passing through the side, and consequently remains there harmless.

Thus a shot of 51^{lbs} with an initial velocity of about 1500 feet, might be expected to perforate a mass of white oak 30 inches thick, at a thousand yards 29 inches, and by its shock, to break through the slight remaining thickness of timber,

splintering the surface where it passes out and driving the fragments before it.

The 51$^{lbs.}$ shell would enter about 23 inches, or three of its own diameters, having in front of it a remaining thickness of wood equal to one of its own diameters. The explosion of the charge, 2$^{lbs.}$, would necessarily act with great effect, whether it breached through front and rear, or only towards the rear,—and must shatter and displace much wood on the outer surface, so as to make a very troublesome and, if near the water-line, dangerous opening. When the distance is less, so that the shell passes through the side, then the office of the shot is accomplished by it, with the additional advantage of exploding the shell inboard, or in the opposite side of the ship.

But when the shot failed to perforate the side by reason of diminished force, caused by greater distance or by ricochetting, or on account of oblique impact, the shell, though effected in its penetration by similar causes, would still exert considerable effect in exploding.

The shot, therefore, derives no advantage from its greater penetration, *except* when it passes through, and when the shell neither perforates nor explodes.

The gist of the question then, between the solid shot and the charged shell, of like weights, rests mainly on the superior accuracy of the one, and the superior power of the other.

If there be any difficulty in striking a given

object, the shot will do so oftener than the shell; if not, the shot will cluster more closely about any desired spot. On the other hand, the power exerted by a single exploding shell is infinitely more destructive than that of many shot.

The few historical facts already cited, are directly corroborative of the results of experiment and reasoning, in regard to the effects of solid shot upon massive wooden structures. Almost any naval action will furnish further evidence; showing incontestably, that ships are capable of successfully resisting for hours the continued fire of the heaviest navy cannon, delivered at the shortest distances. And, beyond these distances but little decisive results have been obtained, or indeed anticipated: so that the custom of naval commanders who sought battle, has been to close without delay, frequently reserving their fire until in the desired position: while the avoidance of near action has never failed to be imputed, and considered as evincing an intention to evade an engagement, and firing at long range has proved to be an useless expenditure of ammunition.

The solution of what common experience has so fully taught, is found in observing the facts derived from experiment; where we see that the splinters from the inside may disable men and equipments, but that outside, the damage to the vessel is little more than contused perforations closely filled with the shattered fibres,

so that no inconvenience results to the hull except when the hole is near the water-line, and then a good plug will keep out most of the water, and the pumps throw off that which filters in. Hence, it is only by the continued repetition of shot after shot, that a ship-of-war is overcome, and principally through the destruction, partial or entire, of her means of offense and manœuvre,—men, guns, masts, yards, &c.; while the general duration of a sea-fight shows, that this is not readily accomplished in a short time.

The action of shells is widely different. Some may fail to strike, some to explode; others may pass through and explode inside; but when lodgment and explosion does occur, the consequences are as destructive as if a number of shot were to strike at once about the same spot. Perhaps even more so,—a large portion of the side is destroyed and all of the appliances within reach more or less damaged; the breach is irreparable at the time, and, if at the water-line, can hardly do less than terminate further defense.

Of course it is essential that this result should constitute the general rule of action with the shell, and not the exception, which will depend mainly on the fuze; and we think it may be reasonably expected that this important detail, when well made and carefully preserved on shipboard, will not often fail to perform its part.

If the reader should be inclined to think that the case here presented overrates the value of the *new arm*, let him turn to writers of acknowledged authority, and he will chance on such expressions as the following:—

Captain Simmons on Heavy Ordnance.

84, 85.—"There is no attainable range where "the effects of loaded shells will not prove "highly important, if ably and judiciously em- "ployed. A shell, deriving its destructive force "from its explosion, is most efficient when pene- "trating to that depth in the side of a ship, at "which solid shot would absolutely be ineffec- "tive."

91.—"The immense results which must arise "from the use of shells, can with difficulty be "imagined by those who have not witnessed their "effect. On shore, the bursting of a shell is im- "posing, but on board ship it must be infinitely "more formidable."

110.—"Loaded shells are the most formidable "projectiles which can be opposed to ships-of- "war."

Sir Howard Douglas.

252.—"These are portentous proofs of the "terrific effects, physical and moral, produced on "a ship by the explosions of shells at rest within "her, even though not imbedded in the mass of "her sides or body; and the like effects must be

"expected to ensue, should an enemy's shell be "planted or lodged in the ship before the explo- "sion takes place."

253.—"It is this faculty of shells, by which "they act as mines, that renders them most des- "tructive to ships. In the experiments carried "on at Brest during the years 1821 and 1824, "at Portsmouth in 1838, and at Woolwich in "1850, the terrific effects of shell-firing on and "in a ship, when the shells, having penetrated "sufficiently into the timbers to lodge and ex- "plode there, took full effect, were strikingly "exemplified."—(See note.)

Captain Sir T. Hastings being one of the three members of the British Ordnance Board, made use of the following most emphatic language to a Parliamentary commission convened for the purpose of inquiry into the state of the Navy.

Alluding to information received concerning the adoption of shells in other Navies, and the necessity imposed of following the example, he says:—

"If our fleet had been brought into contact "with that of the French or the Americans so "armed, it is perfectly clear that we should have "had no chance whatever against such an arma- "ment."—(5000.)

It will be perceived that, strictly speaking, the foregoing remarks only apply to the question as

stated in the form supposed to be preferable for solution; that is, whether, *with a given weight, the projectile should be a shot or a shell*, and *the gun constructed accordingly*. This, however, is not the shape in which the problem is presented under the existing state of things; for the weights of shell-guns actually in use, seldom correspond with those of shot-guns, and it may be of interest to inquire how such differences qualify the relative value of the two projectiles as it appears in the case just assumed.

For the gradual encroachment which the shell-gun has effected upon the regular establishment of shot-guns, and which has converted it from an unimportant auxiliary to a very commanding element of the whole battery, has excited the attention of Naval officers, and some diversity of opinion may naturally exist among them regarding the extent to which the shell system should be carried. The most eminent writers on ordnance have also discussed the question at length; their opinions are necessarily of great interest, and as they are generally adverse to any very considerable extension of the shell system on shipboard, even as actually practised, it will be well to glance at their objections and examine briefly the reasons given therefor.

That well-known authority, Sir Howard Douglas, thus states the proposition:—

"It is now intended to make a comparison be-
"tween the shell-guns and the solid shot-guns,

"which are at present employed in the Naval "service of this country, in order to ascertain "whether or not the shell-guns do really possess "such qualities with respect to extent of range, "accuracy of fire and penetrating force, as to "warrant their application as the pivot guns of "steamers: which assuredly should, with equal "or inferior weight, possess those qualities in "the highest degree. It is proposed at the "same time to ascertain whether or not shell-"guns are better adapted than others for the "broadside batteries of ships, in which situations, "rapid firing and extensive perforations are the "essential condition of their action."

The comparison to be instituted is limited by Sir Howard Douglas to the Ordnance of the British Navy, but the question has an interest for ourselves of much wider scope, and its consideration will therefore be extended by including the principal broadside guns of the chief maritime nations.

In pursuing the comparison, Sir Howard Douglas assumes the employment of hollow shot to a great extent in the shell-guns,—it is therefore proper to premise, that the present argument will proceed solely with reference to the use of shells in shell-guns,—*hollow shot, never.* It is indeed difficult to comprehend what possible purpose is to be effected by the adoption of hollow shot, if the cavity is not filled with powder so as to obtain the advantage of explosion.

The hollow shot can act only by impact like the solid shot, and its efforts must of course be inferior whenever accuracy and penetration are important, because of its inferior weight relatively to its volume. Why then submit to the manifold inconveniences of an additional calibre, unwelcome at any time, but particularly so when the long sought unity had just been accomplished, if it were not that this, and the abatement of power in the projectile itself, were to be compensated by some other quality? *Without such object, the shell-guns were worse than useless.* The substitution of *explosion for impact* by employing loaded projectiles, is the end and object for which this new ordnance was created, and to fail in so applying it seems most incomprehensible.

It is not credible, indeed, that so palpable an incongruity would be tolerated in service; but as it has been allowed by eminent authorities to enter as an element into the discussion of the relative merits of shot and shell-guns, and most materially to influence the general conclusions, it seems requisite to premise the present argument with a distinct protest against any such absurdity.

Simmons, in his able essay on Heavy Ordnance, has fully set forth in detail and established the worthlessness of hollow shot.

It is to be understood, therefore, that hollow shot, or rather uncharged shells, have no place in the following argument; plainly because the

shell-gun is introduced specially to give application to explosive projectiles, and not to hollow shot, which is indeed nothing but an emasculated shell, stripped of its peculiar power.*

1st. Are shell-guns better adapted than shot-guns for the broadside batteries of ships, in which situations, rapid firing and extensive perforations are the essential condition of their action?

Keeping in view that the ordnance actually in use is here referred to, let us note that, by the established regulations of the United States and England, the broadsides of all gun-decks are armed with long 32-pdrs. and 8-inch shell-guns. The French use the long 30-pdr., and the Canon Obusier of 22$^{cent.}$ for the same purpose. The capacities of these pieces of ordnance may be derived from the following elements:—

LONG 32-PDRS.

	Weight.			Bore.		Shot.	
	Gun.	Chge.	Shot.	Length.	Diam.	Diam.	Windge.
United States 32-pdr.	57$^{cwt.}$	9$^{lbs.}$	32¼ $^{lbs.}$	107.9	6.40	6.250	0.150
British . . . 32-pdr.	56 "	10 "	31½ "	107.2	6.41	6.235	0.175
French . . . 30-pdr.	59¾ "	10¾ "	33¾ "	104.0	6.486	6.285	0.201

* To these remarks I may add, that the Regulations of the U. S. Navy no longer recognise the use of hollow shot; a portion of the shells are sent on ship-board bouched only, and not strapped nor fuzed,—but this is because the arrangements of ships built before shells were introduced, are only sufficient to receive a portion of the shells in boxes; and the remainder are stowed in bulk and fitted, when required, to supply the current expenditure of the ship.

The 30-pdr. has the advantage over the 32-pdrs., in weight of charge, and in size and weight of shot; but its bore is somewhat shorter, and the strength of French powder considerably less than the English or American. The United States gun is nearly identical with the British, the shot larger and heavier, the charge less, and the powder rather more active. But on the whole, there are probably no material differences in the ordnance power of the pieces; certainly none that are not readily removable, by equalizing the weights of charge and shot,—all of them having capabilities of endurance about similar, and *for all practical purposes*, they may be considered *of equal power.*

The dimensions, &c., of the 8-inch shell-guns are:—

	Weight			Bore.		Shell.		
	Gun.	Chg.	Shell Ld.	Length	Diam.	Diam.	Weight.	Chg.
						in.		
United States,	63 cwt.	9 lbs.	51 lbs.	100½ in.	8. in.	7.85	lbs. .15	2 lbs.
England, . .	65 "	10	51*	105½	8.05	7.925	.125	—
France, . . .	71 "	7½	61½*	104	8.794	8.674	.12	4½

The data furnished by practice with U. S. cannon will be made use of, because we are possessed of more certain information in regard to their operation. If any differences in this respect do exist between the 32-pdrs. and 30-pdrs., or British and U. S. shell-guns here named, they are due, not to differences in the

* If completely filled with powder.

real capacities of the several pieces, but to diversities of opinion and practice as to the preferable manner of developing their best qualities.

RANGE.

The ranges of the United States long 32-pdr. and 8-inch shell-gun compare thus; their height above the water being nine feet:—

	2°	3°	4°	5°
8-in. Shell-gun,...	970	1260	1540	1770
32-pdr.....	1170	1510	1750	1940

So that to attain the same distances as the 32-pdr., it will be necessary to give a greater elevation to the 8-in. of 63 cwt. Wherefore, with like elevations, the range of the 32-pdr. is greater than that of the 8-in. shell-gun, and would consequently be deemed the more accurate piece. We shall presently see, however, that this conclusion would be erroneous, and that, advantageous as directness of flight undeniably is, it is not the only element necessary to precision in gun practice.

ACCURACY.

It has no doubt been recognised that the 51 lbs. shell used for the purpose of illustration in comparing shot and shells of equal weight, is the 8-in. shell of the U. S. Navy.

In that comparison it was distinctly admitted that the 51 lbs. shell should be inferior to the 51 lbs. shot in accuracy, but no opportunity presented for making actual trials of the extent to which this deficiency existed.

Satisfactory evidence in regard to accuracy is not wanting in the present case, as the long 32-pdr. has been compared with the 8-in. shell-gun, under circumstances most favorable to a fair estimate of the relative precision of the two pieces. The utmost care was observed to have every detail of the practice as rigorously exact as possible. Each round was fired with smooth and spherical projectiles, selected by gauges differing not more than one-hundredth of an inch, more or less, from the true diameter, and free from any important variations in weight, the shot having, unavoidably, the advantage in this respect.

The guns were elevated by the quadrant, and the atmosphere was always perfectly calm.

The results are shown by the following extracts from the records:—

U. S. N. 32-Pdr. of 57cwt.

Charge=9lbs. Elevation=2° 33′. Weather calm.

No.	Ranges in yds.	Remarks.
1.	1383	Missed, deviated to the right.
2.	1340	" " " "
3.	1238	" " to the left.
4.	1284	Deviated to the left on ricochet.
5.	1342	Missed, deviated to the right.
6.	1368	" " " "
7.	1419	" went over.
8.	1326	Struck direct.
9.	1363	" "
10.	1278	" on ricochet.
	1324	

Of the ten shot fired from this gun, only three struck the screen, one of which was on ricochet (10), having fallen 22 yards short. The other seven either passed over (7), or to the right or left—or they fall short and deviated to the right and left (3, 4, 2, 5, 6, 1.) One of them (4) grazed the pole to the left of the screen.

U. S. N. 8-inch of 63cwt.

Charge=9lbs. Elevation=3° 12′. Weather calm.

No.	Ranges in yds.	Remarks.
1.	1383	Missed, deviated to the left.
2.	1390	Struck direct.
3.	1328	" "
4.	1334	" "
5.	1374	Missed, deviated to the right.
6.	1326	Devi'ed, and struck the left pole.
7.	1317	Struck direct.
8.	1363	" "
9.	1282	" on ricochet.
10.	1428	Missed, went over.
	1357	

Of the ten shells from this piece, 5 struck direct—one on ricochet (9)—one deviated to the right (5)—two to the left (6, 1)—and one passed over the screen (10.)

So that at 1300 yards, the 8-inch shell-gun proved to be more accurate than the long 32-pdr. in the ratio of 5 to 2, or including the ricochet, 6 to 3, and is therefore manifestly superior to it

Relative Accuracy in 10 Rounds

Screen 40 × 20 feet distance 1500 yards

U. S. Navy 42 pdr at 57

U. S. Navy [illegible] at 0.3

U. S. N. 32-PDR. OF 57cwt.

Charge=9lbs. Elevation=2° 33′. Weather calm.

No.	Ranges in yds.	Remarks.
1.	1383	Missed, deviated to the right.
2.	1340	" " "
3.	1238	" " to the left.
4.	1284	Deviated to the left on ricochet.
5.	1342	Missed, deviated to the right.
6.	1368	" " "
7.	1419	" went over.
8.	1326	Struck direct.
9.	1363	" "
10.	1278	" on ricochet.
	1324	

Of the ten shot fired this gun, only three the screen, one of was on ricochet (10), fallen 22 yards shor other seven either over (7), or to the left—or they fell deviated to the left (3, 4, 2, 5, 6, them (4) grazed the left of the

U. S. N. 8-INCH OF 63cwt.

Charge=9lbs. Elevation=3° 12′. Weathe

No.	Ranges in yds.	Remarks.
1.	1383	Missed, deviated to the left.
2.	1390	Struck direct.
3.	1323	" "
4.	1334	" "
5.	1374	Missed, deviated to the right.
6.	1326	Devi'ed, and struck the left pole.
7.	1317	Struck direct.
8.	1363	" "
9.	1282	" on ricochet.
10.	1428	Missed, went over.
	1357	

Of the

So that at 1300 yards, the proved to be more accurate than in the ratio of 5 to 2, or includ 6 to 3, and is therefore manif

in the capacity for striking an equal surface at this distance, even though the directness of its flight was prejudiced by an increased elevation of two-thirds of a degree. At greater or shorter distances, it is inferable that a like relation exists in the divergence of the trajectories.

Sir Howard Douglas appears to have arrived at an entirely opposite conclusion, derived from certain practice executed on board the British Gunnery-ship *Excellent*, and cited at page 292 of the work on "Naval Gunnery."

It seems that a target was placed at 400 yards from that ship, the size not given, and the long 32-pdr. fired eleven times at it in $7^{min.}\ 10^{sec.}$. A like number of hollow shot were fired from the 8-in. of $65^{cwt.}$ in $7^{min.}\ 40^{sec.}$. Every one of the 32-pdr. shot, and only four of the 8-in. struck.

This result is considered by Sir Howard Douglas as confirmatory of his previous opinion in favor of the accuracy of the long 32-pdr. But we believe that a scrutiny of the circumstances under which this practice occurred, will show that the conclusion is not warranted; and, indeed, the object of the particular practice seems rather to have been to ascertain the extent to which accuracy was likely to be affected by the greatest possible celerity of fire.

It will occur to any one that the rate of firing was extraordinarily rapid, the intervals between the rounds being 39 seconds for the 32-pdr. shot, and 42 seconds for the 8-in. hollow shot, which

obviously rendered it impossible to point the guns properly,—for the intervals between each fire were too brief to permit the dispersion of the smoke, so that all view of the object was precluded after the first round, and even if the target had been plainly visible, any correction in the aim of the piece could not have been attempted. Wherefore, the general accuracy of the eleven fires depended in the first place on the proper adjustment of the gun, and afterwards on the exactitude with which it was adhered to when the object could not be seen.

Now it would seem that these conditions were fully complied with as regarded the long 32-pdr., for the practice with it was most admirable, and no shot from it failed to strike the target.

In the practice with the 8$^{in.}$ of 65$^{cwt.}$, the first objection is to its elevation, which seems to have been insufficient. According to the tables of the *Excellent*, quoted by Sir Howard Douglas, the range of hollow shot is 330 yards from an 8^{inch} gun (charge 10$^{lbs.}$) elevated $\frac{3}{8}^{ths}$ of a degree;* while the range of shot from a long 32-pdr., (charge 8$^{lbs.}$) also elevated $\frac{3}{8}^{ths}$ of a degree, is 20 yards greater,† both guns being 5$\frac{1}{3}$ feet above water.

If then the distance of the object, on the occasion referred to, required the 32-pdr. to be elevated $\frac{8}{16}^{ths}$ of a degree (which the result proves

* Page 568. † Page 570.

to have been the case, as every shot struck the mark), the 8in. shell-gun should have had an elevation somewhat *greater:* instead of which, it had $\frac{3^{ths}}{16}$ of a degree *less* than the 32-pdr. and, as might be reasonably expected, the hollow shot would not range as far as the 32-pdr. shot, which is also verified by the facts noted in the record; for it appears that seven of the 8in. shells fell short of the target, and only four struck it, probably on ricochet.

Hence it is undeniable that this failure of the 8in. shells to strike, cannot properly be attributed to a want of *accuracy in the piece*, so long as there was such a lack of *accuracy in its use;* and it is not admissible to cite the results as proper to prove the comparative precision of the 32-pdr. and the 8in. shell-gun. The practice certainly exhibits the degree of accuracy that is possible under the circumstances; and this was probably the real object. But it is impossible to accept it as an evidence of the relative accuracy of the two pieces, because we know that the 8in. gun was incorrectly aimed,—and even if this objection to the practice had not existed, the rapidity with which it was executed, would have been sufficient to make it of slight account in the present question.

Suppose the error of direction had been with the 32-pdr. instead of the 8in. gun, and the results had varied correspondingly, would they

have been allowable as evidence in the comparison between the two pieces?

There is good reason then to refuse the deductions drawn from this practice of the *Excellent*, so far as regards the comparative accuracy of the 32-pdr. and 8$^{in.}$ shell-gun, and to assume that they do not in fact conflict with results which are shown to have been obtained under a strict regard to necessary conditions.

Penetration.

Using the formula already given for determining the penetration of 32-pdr. shot and 8$^{in.}$ shells, fired from U. S. N. cannon of those classes with the common charge assigned by Regulation (9$^{lbs.}$), we shall have the following results,—the substance fired at being solid white oak,—the flight of the projectiles direct—and the impact perpendicular to the surface.

		Distance in yards.			
Charge		500	1000	1500	2000
32-pdr. shot,	9$^{lbs.}$	38$\frac{3}{4}^{ins.}$	26$\frac{1}{2}^{ins.}$	18$\frac{1}{4}^{ins.}$	12$\frac{1}{2}^{ins.}$
8$^{in.}$ shells,	9$^{lbs.}$	33$\frac{1}{4}^{ins.}$	23$^{ins.}$	16$^{ins.}$	11$^{ins.}$

From these quantities it would appear, that whenever the 32-pdr. shot will pass through, the 8$^{in.}$ shell will lodge sufficiently deep to approach its maximum effect on exploding; and this being the case, it remains to choose between the

perforation of the shot or the probable explosion of the shell, as most efficacious. The facts already cited to preface these remarks, certainly leave little room to doubt which would prove decisive in the least time,—besides, in firing at distant objects the total effect is augmented by the greater number of 8$^{\text{in.}}$ shells which strike; they being so much more numerous than the 32-pdr. shot, that even after making the usual deduction for failures of fuzes, the remainder that explode is one-third greater than the number of 32-pdr. shot that strike.

Hence it is to be inferred that the 8$^{\text{inch}}$ shell is not only superior in indiviual effect to the 32-pdr. shot, but when accuracy is a condition, the repetition of the effect is more certain.

If the object be so near that one can hardly fail to strike it, with shot or shell, the former avoids the loss of effect arising from inferior accuracy, but the latter acquires the certainty of perforating equally with the shot, and with the increased destructive power due to its greater mass and surface; so that it may perforate one or both sides and explode in either or in the open quarters of the ship;—acting as a shot certainly, and, most probably, in the double capacity of shot and shell.

It often happens, however, even in close action that many shot fail to traverse the side, and are consequently lost, particularly in a raking fire, when the massive assemblage of heavy timbers,

strongly bolted at the bow and stern, oppose unusual resistance to the impact. Here the advantage of an exploding projectile will become apparent.

CELERITY OF FIRE.

The practice cited by Sir Howard Douglas is so conclusive on this point, that argument, or even additional facts are needless. On the occasion referred to, eleven rounds were fired from the long 32-pdr. in $7^{m.}$ $10^{sec.}$, and from the $8^{in.}$ of $65^{cwt.}$ in $7^{m.}$ $40^{sec.}$, leaving a difference of about $\frac{1}{11}^{th}$ in favor of the former, which is of little real account, particularly as the advantage of weight of projectile is obviously with the shell-gun,—for in the same time that the 32-pdr. discharged $352^{lbs.}$ of shot, the $8^{in.}$ of $65^{cwt.}$ threw more than $500^{lbs.}$ of shell.

To double-shot the 32-pdr. in order to increase both number and weight of projectile, might cause more loss of penetration than would be advisable, and certainly diminish the celerity of fire considerably.

The French shell-gun (canon obusier of 80, or $22^{cent.}$) differs too widely from those of England and the United States to be classed with them in the foregoing remarks.

GUNS.

	Weight.	Bore. Diam.	Bore. Length.	Charge.
	lbs.	in.	in.	lbs.
8in of 65cwt.	7300	8.05	105.27	10
Can. Obus. of 22cent.	8000	8.79	104.04	7¾

PROJECTILES.

	Diam.	Weight empty.	Content in Cu. in.	Content in Powder.	Loaded shell.
	in.	lbs.		lbs.	lbs.
8in of 65cwt.	7.925	48	73	2½	50½
22cent., or 80-pdr.	8.674	56¾	122	4	60½

Some differences exist in the modes of charging the shell. The French use incendiary matter, which reduces the quantity of powder, while it is believed that the practice is different in England and the United States.

The content of the shell is, however, the best measure of its explosive power, whatever be the nature of the charge. Hence, the capacities of the cavities are given with their equivalents in powder at the ordinary density.*

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* The English shells weigh 48lbs. according to Sir Howard Douglas, and the papers reported by the Committee of the Commons. But their content is not so satisfactorily stated; in one place Sir H. Douglas says it is 2lbs. 11ozs. (page 198, note); in another (page 262) he cites the established allowance as 2lbs. 4ozs. The French *Aide Memoire Naval* (page 276) assigns 4½lbs. as the content in powder of the 22cent. shell, and also states the usual service charge to be from 1¼lbs. to 2½lbs. of powder and ½lb. of incendiary composition.

The ranges obtained by these pieces, according to the best data at disposal, are:

		1°	2°	3°	4°	5°	
8in. of 65cwt.	Practice of the *Excellent*, by Sir H. Douglas.	645,	1030,	1270,	1460,	1650	yards.

	°	1°30	5°	10°	
Can. Obus. 22cent. *Gavre*,	372	722	1467	2213	yards.

	1°14′	2°24′	3°24′	4°30′	5°45′	
Can. Obus. 22cent. *Aide Mem. Navale*,	656,	875,	1094,	1313,	1531	yds.

	1°	2°	3°	4°	5°
8in.	645	1030	1270	1460	1650
22 cent.	530	915	1128	1300	1467
	115	115	142	160	183
		⅛	⅛	⅛	⅛

The inferiority of the French shell in range is considerable, and it is probable that this cannot be remedied, as the charge used is, perhaps, quite as much as the inertia of the gun permits.

Again, the specific gravity of the English shell is about 5.4, while that of the French is 4.9.

Both of these causes contribute to decrease the precision of the canon obusier, though some compensation may exist in other influences.

The penetrations deduced by formulas already given, are,—

	Charge.	In. velo.	Yds. 500	Yds. 1000	Yds. 1500	Yds. 2000
	lbs.	feet.	in.	in.	in.	in.
8in. shell,	10	1584	34.6	23.8	16.3	11.3
22cent. shell,	7¾	1386	29.3	20.2	13.9	9.6

From these data it is inferable, generally, that the French shell is inferior to the English shell in penetration and in accuracy. But it has the advantage in area of perforation, in power of concussion, and, most decidedly, in explosive power.

So that the ordnance value of the two projectiles will depend on circumstances. At moderate distances, where the failures to strike cannot be considerable, and the penetration is sufficient to ensure effect to the explosion, the French shell must be far more decisive than the English. But beyond, the superior accuracy of the 8$^{\text{ths}}$ shell, and its greater depth of lodgment will compensate for the difference in explosive power, and give it the advantage.

It is impossible, from such general facts, to say with any exactness where the advantage of one begins and the other ends.

It is known generally, that the effect of explosion depends on the quantity of powder in the shell and on the depth of its lodgment, and there is no difficulty in deciding between two shells which have a common charge and differ in penetration, or which have a like penetration and differ in the charge. But when they vary in both of these prime elements, and their relative accuracy is also unknown, then the case becomes too complicated to be solved fully by means of any facts yet published.

PIVOT-GUNS.

The other branch of the query put by Sir Howard Douglas, is stated thus:—"Do the "shell-guns at present employed in the British "naval service, really possess such qualities with "respect to extent of range, accuracy of fire "and penetrating force, as to warrant their ap- "plication as the pivot-guns of steamers: which "assuredly should, with equal or inferior weight, "possess those qualities in the highest degree."

The only shell-gun appropriated to pivot service in the British navy is the 10-in. of 84$^{cwt.}$, (afterwards of 86$^{cwt.}$;) and, until very recently, its fac-simile (10-in. of 86$^{cwt.}$) has served a like purpose in the United States navy. The French, it is believed, have no special shell-gun for pivot. That of 27$^{cent.}$ was so designed, but, if ever used, has been laid aside; consequently their only remaining shell-gun, that of 22$^{cent.}$, must serve, if wanted, for pivot as well as for broadside.

The 10-in. of 84$^{cwt.}$ is the first class of shell-gun that was tried by the English, (1831,) and was their only pivot-gun until the 56-pdr. (Monk) and 68-pdr. (Dundas) were introduced. The latter seems now, from its general use, to be their favorite piece.

The English practice obtained implicitly in the United States navy. The earliest of the large

Steamers carried 10-in. of 86 cwt. on pivots,—and the 68-pdr. was followed in order by the 64-pdr.

The French have recently adopted a long 50-pdr., avowedly for the broadside, though as yet its application in this way has been very limited. Its weight and power make it more suitable for pivot service, but it is not known to have been so authorized.

The several details which concern the power of these heavy ordnance, may be stated thus:—

	Weight.			Bore.		Shot.		Shl.
	Gun.	Of Shell, or Shot.	Chge.	Length.	Diam.	Diam.	Windage.	Chge.
				in.	in.	in.	in.	
10-in. U. S. N.,.....	86 cwt.	104 lbs.	10 lbs.	106.0	10.0	9.85	0.15	4 lbs.
10-in. British,.....	84 & 86	87	12	109.33	10.0	9.84	0.16	5½*
50-pdr., French,...	91 cwt.	55½	17½	121.84	7.64	7.44	.197	—
56-pdr., British,...	98 "	55½	16	124.87	7.65	7.475	0.175	1½*
64-pdr., U. S. N.,..105 "		64	16	124.2	8.0	7.85	0.15	2
68-pdr., British,...	87 "	67	14	——	8.12	7.92	0.2	2½*
68-pdr., " ...	95 "	67	16	——	8.12	7.92	0.2	2½*

NOTE.—In all essential points the French 50-pdr. is similar to the British 56-pdr., being immaterially lighter.

No very rigid scrutiny is required to decide on the unfitness of the two 10-in. shell-guns for pivot service, when, as Sir Howard Douglas states, the greatest accuracy, force, and range are essential: these they are not only very deficient in, but are plainly inferior to the heavier 50-pdr., 56-pdr., 64-pdr., and 68-pdr.

The 10-in. shell is most formidable in its effects; far more so than any shot or shell from

* Sir H. Douglas, (262.)

the heavy shot-guns above named: but the 86cwt. gun, appropriated to it, is deficient in the qualities necessary to give it accuracy and penetration —wherefore, it is certain to be commanded by the 68-pdr., &c., at all distances except the most moderate,—then its power will be felt to be far too superior to be trifled with.

It is singular, that in copying the English gun, we adopted a different charge and shell, and in so doing, exaggerated the defects of this class of ordnance very materially, thus:—

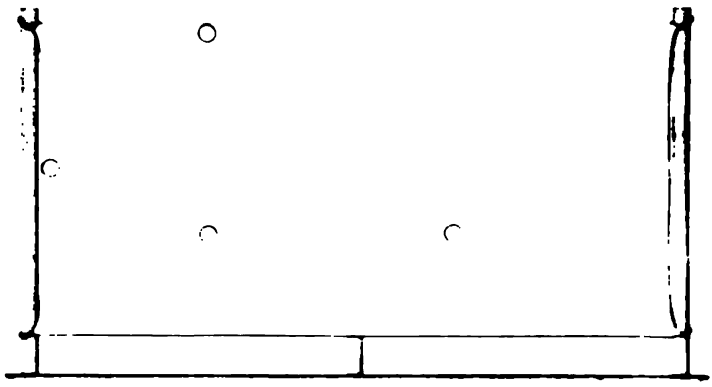
	British.	U. S. N.
Charge of Gun,.....	12lbs.	10lbs.
" of Shell,.....	5½	4
Weight of loaded Shell,....	87½	104

The shell was already quite as heavy as the gun could sustain, and hence, by increasing its weight, it became necessary to diminish the charge. So that a shell of 104lbs. was to be propelled by 10lbs. of powder. The consequence was, that a farther diminution ensued in the very particulars wherein the English 10-in. gun was already deficient, viz., in accuracy and penetration.

The precision of the United States Navy 10-in. of 86cwt. is even less than its inferior calibre the 8-in. of 63cwt., as will be perceived by the sketch of a screen, herewith annexed, at which were fired 10 shells in the manner customary for experimental practice:—

U. S. Navy 10 in. of 86 cwt. Ten Shells fired

Screen 40 × 20 feet, distance 1300 yards.



Scale ⅛ in 1 foot

10-INCH SHELL-GUN OF 86cwt.

Charge=10lbs. Elevation=4°. Weather calm.

No.	Ranges in yds.	Remarks.
1.	1383	Went over and dev'd to the left.
2.	1403	" " "
3.	1338	Struck direct.
4.	1324	" "
5.	1254	Fell short and dev'd to the right.
6.	1365	Missed, and deviated to the left.
7.	1343	" " "
8.	1267	Struck on ricochet.
9.	1368	" direct.
10.	1598	Went over.
(of 9)—	1338	

Of the ten shells fired from this gun, only *four* struck the screen, one of which was on ricochet (8), having fallen 33 yds. short; *two* missed the screen by going too high, and also by lateral deviation. *One* fell short and missed, by deviating to the right. The 10th went far over,

The reason of the change in weight of projectile does not appear; but it is certain that the English shell is in all respects the most suitable that could be adopted for the 10$^{in.}$ shell-gun of 86$^{cwt.}$, and it may be said that the U. S. N. shell is just the reverse.

It has been customary in the English ships that carried several pivot guns, to associate the 10$^{in.}$ of 86$^{cwt.}$ with the 68-pdr. or 56-pdr., thereby combining the distinctive advantages of each, and measurably avoiding the consequences of their defects; which notwithstanding the complication, is perhaps the best application of existing means; though after all, but an indifferent substitute for ordnance that, by their construction might unite in the greatest practicable degree, the qualities of the 68-pdr. and the 10$^{in.}$ of 86$^{cwt.}$.

The French canon obusier of 22$^{cent.}$ is plainly no match for the 10$^{in.}$ of 86$^{cwt.}$ under any circumstances, and as a pivot-gun, is entirely out of the question for ships of war.

This brief and desultory comment is quite as much as the unsettled and imperfect state of the pivot ordnance admits. The shell-guns used for that purpose by the English and Americans are obviously unfit for it—being neither heavy enough, nor of proper construction: wherefore, the immediate question of a preference for them, or the 68-pdrs. and the like, as pivot-guns, is readily disposed of in favor of the latter.

But it is not therefore to be inferred, that the

shell-gun is necessarily inferior to the shot-gun for purposes requiring range, precision, and power, or in other words, for pivot service, supposing that the pieces are of like weight and their capacity properly developed.

If, for instance, the weight in metal of the 64-pdr. was made into a shell-gun fashioned upon correct principles—the relative accuracy of the two guns, at a distant object, may be assumed as 75 to 90: and the probable failure of fuzes to act, would reduce the peculiar operation of the shell in the ratio of 64 to 90, that is, the explosions of 4^{lbs} charges would be to the impact of 64-pdr. shot, in number as 2 to 3.

But the weight of the shell,—not less than 100^{lbs},—moving with the velocity imparted by an admissible charge, will have produced a momentum which is sufficient to penetrate a ship's side at a distance not much short of the limit of effective long practice. So that the impact of such a projectile is a matter of consideration, and not to be neglected in the estimate of its power; consequently its superior surface and mass will affect correspondingly the area of orifice, power of concussion, &c.

The conclusions to which this course of remark leads, may be briefly summed, thus:—

1—Shells are of more effect against ships than shot of like weight, both being used under like conditions.

2—The present long 32-pdrs. and the French 30-pdr. are inferior to the 8$^{in.}$ shell-guns in accuracy and power, and therefore less efficient for long or short ranges.

3—The French canon-obusier of 22$^{cwt.}$ is more powerful than the 8$^{in.}$ shell-guns at short or moderate distances; but the latter have the advantage at longer ranges, though it is not certain that decisive results are then obtainable.

4—The 10$^{in.}$ shell is of superior effect to the shot of 64 or 68-pdrs.; but the gun assigned for its use is too light to propel it properly. Hence, its superiority is restricted to ranges much exceeded by the the 68-pdrs. and other guns of like character, and the use of the 10$^{in.}$ of 86$^{cwt.}$ as a pivot-gun, is not to be recommended.

VII.

COMPOSITION OF BATTERIES.

Armament of ships in the United States, France and England, based on a Unit-calibre, with a proportion of Shell-guns.—French organization—English—American—Unit-calibre practically the same in all.—First adopted by France in 1829.—Evils of various calibres—some remedy had become unavoidable—not attained by the new system, which is still complicated, and sacrificed the best calibre in the line-of-battle-ships of two Navies.—Uniformity of calibre violated by the introduction of Shell-guns—the number of which was at first small—gradually increased in the English ships—and in those of the United States.—Broadsides of English—French—and United States' ships compared.—Batteries of steamers—reduced to a low scale by the side wheel.—Introduction of the screw, and restoration of the broadside.

The remarks just concluded will be understood to apply to the comparative values of ordnance, individually considered.

If naval batteries were restricted to a single description of cannon, it would be as easy to estimate the relative force of ships as of the pieces they carry.

But the habitual practice of using a variety of guns for the purpose, produces so much complication that it is difficult to form any reliable judgment of the absolute or comparative power of broadsides.

The batteries of English, French, and American ships are composed chiefly of 32-pdrs., or their equivalent the 30-pdr.—differing in weight

according to the class of vessel or the order of the tier. With these are associated a limited number of 8-in. or 22$^{cent.}$ shell-guns.

French Ship-batteries.

The changes that have been progressively made in these, are stated in an official document to have occurred in the years 1812, 1829, 1837, 1848, and 1849.

In 1812, the calibres were 36, 24, 18 and 12-pdr. cannon and carronades.

In 1829, it was desired to get rid of the inconveniences occasioned by this diversity of bores, and the 30-pdr. was adopted for all batteries, classes of different weights being used according to the capacity of the ship or to the height above water. The 80-pdr. of Paixhans was already known and had been tried, but the results were not sufficiently complete to admit of its being assigned a place in the prescribed armament of the fleet. This was, however, found expedient in 1837, and thus the unity of calibre which the French authorities so much desired, and had so nearly arrived at, suffered further interruption. The decree of 1848 increased the number of 22$^{cent.}$ shell-guns, and that of 1849, introduced 50-pdr. cannon as a substitute for some of the former; it also suppressed the carronade.

Armament of French Ships-of-War.—1848.

FIRST RATES.

1st deck.	8 Shell-guns of 22 cent. No. 1, 24 long 30-pdrs.,	32	
2d deck.	8 Shell-guns of 22 cent. No. 2, 26 short 30-pdrs.,	34	116 guns.
3d deck.	34 Shell-guns of 16 cent.,	34	
Spar-deck.	4 Shell-guns of 16 cent., 12 30-pdr. carronades,	16	

SECOND RATES.

1st deck.	8 Shell-guns of 22 cent. No. 1, 24 long 30-pdrs.,	32	
2d deck.	8 Shell-guns of 22, cent. No. 2, 26 short 30-pdrs.,	34	96 guns.
Spar-deck.	4 Shell-guns of 16 cent., 26 30-pdr. carronades,	30	

THIRD RATE.

1st deck.	8 Shell-guns of 22 cent. No. 1, 22 long 30-pdrs.,	30	
2d deck.	8 Shell-guns of 22 cent. No. 2, 24 short 30-pdr.,	32	86 guns.
Spar-deck.	4 Shell-guns of 16 cent., 20 30-pdr. carronades,	24	

FOURTH RATE.

1st deck.	8 Shell-guns of 22 cent. No. 1, 20 long 30-pdrs.,	28	
2d deck.	8 Shell-guns of 22 cent. No. 2, 22 short 30-pdrs.,	30	76 guns.
Spar-deck.	4 Shell-guns of 16 cent., 14 30-pdr. carronades,	18	

FIRST CLASS FRIGATES.

Gun-deck.	4 Shell-guns of 22 cwt. No. 1,		60 guns.
	26 long 30-pdrs.,	30	
Spar-deck.	4 Shell-guns 16 cwt.,		
	26 30-pdr. carronades,	30	

SECOND CLASS FRIGATES.

Gun-deck.	4 Shell-guns of 22 cwt. No. 2,		50 guns.
	24 long 30-pdrs.,	28	
Spar-deck.	4 Shell-guns of 16 cwt.,		
	18 30-pdr. carronades,	22	

THIRD CLASS FRIGATES.

Gun-deck.	2 Shell-guns of 22 cwt.,		40 guns.
	24 short 30-pdrs.,	26	
Spar-deck.	4 Shell-guns of 16 cwt.,		
	10 30-pdr. carronades,	14	

FIRST CLASS CORVETTE.

Gun-deck.	2 Shell-guns of 22 cwt. No. 2,		30 guns.
	22 Shell-guns of 16 cwt.,	24	
Spar-deck.	6 Carronades, 18-pdr.,	6	

(1849.)

Decree of July 27th, 1849, regulating the armament of Ships of War.

Article 1.—The Batteries of ships herein specified, shall in future be regulated as follows:—

FIRST RATES.

1st deck.	4 Shell-guns of 22$^{cent.}$ No. 1,		
	6 50-pdrs., *		
	22 30-pdrs., No. 1,	32	
2d deck.	6 Shell-guns of 22$^{cent.}$ No. 2,		112 guns.
	28 30-pdrs., No. 2,	34	
3d deck.	34 30-pdrs., No. 3,	34	
Spar-deck.	12 30-pdrs., No. 4,	12	

SECOND RATES.

1st deck.	4 Shell-guns of 22$^{cent.}$ No. 1,		
	6 50-pdrs.; 22 30-pdrs., No. 1,	32	
2d deck.	6 Shell-guns of 22$^{cent.}$ No. 2,		90 guns.
	28 30-pdrs., No. 2,	34	
Spar-deck.	24 30-pdrs., No. 3,	24	

THIRD RATES.

(*New model.*)

1st deck.	4 Shell-guns of 22$^{cent.}$ No. 1,		
	6 50-pdrs.; 20 30-pdrs., No. 1,	30	
2d deck.	6 Shell-guns of 22$^{cent.}$ No. 2,		82 guns.
	26 30-pdrs., No. 2,	32	
Spar-deck.	20 30-pdrs. of No. 3,	20	

THIRD RATES.

(*Old model, called an* 86.)

1st deck.	4 Shell-guns of 22$^{cent.}$ No. 1,		
	26 30-pdrs. No. 1,	30	
2d deck.	4 Shell-guns of 22$^{cent.}$ No. 2,		80 guns.
	28 30-pdrs., No. 2,	32	
Spar-deck.	18 30-pdrs., No. 4,	18	

* To be placed as near as possible in the centre of the Battery.

FOURTH RATE.

(*New model.*)

1*st deck.*	4 Shell-guns of 22cwt. No. 1,.....		
	4 50-pdrs.; 20 30-pdrs., No. 1,.....	28	74 guns.
2*d deck.*	4 Shell-guns of 22cwt. No, 2,.....		
	26 30-pdrs., No. 2,.....	30	
Spar-deck.	16 30-pdrs., No. 4,.....	16	

FOURTH RATE.

(*Old model, called a* 74.)

1*st deck.*	4 Shell-guns of 22cwt. No. 1,.....		
	24 36-pdrs.,.....	28	70 guns.
2*d deck.*	30 long 18-pdrs.,.....	30	
Spar-deck.	12 30-pdrs., No. 4,.....	12	

FIRST CLASS FRIGATES.

Gun deck.	2 Shell-guns of 22cwt. No. 1,.....		
	2 50-pdrs.; 26 30-pdrs., No. 1,.....	30	50 guns.
Spar-deck.	2 30-pdrs. No. 1; 18 30-pdrs. No. 3.	20	

RAZEES.

Gun-deck.	2 Shell-guns of 22cwt. No. 1,.....		
	2 50-pdrs.; 24 30-pdrs.. No. 1,.....	28	50 guns.
Spar-deck.	2 30-pdrs., No. 1; 20 30-pdrs., No. 3,	22	

SECOND CLASS FRIGATES.

Gun-deck.	2 Shell-guns of 22cwt. No. 2.....		
	2 50-pdrs.; 24 30-pdrs., No. 2,.....	28	46 guns.
Spar-deck.	2 30-pdrs., No. 1; 16 30-pdrs. No. 4,	18	

THIRD CLASS FRIGATES.

(*New model.*)

Gun-deck.	2 Shell-guns of 22$^{cwt.}$ No. 2,.....		40 guns.
	2 50-pdrs.; 22 30-pdrs., No. 2.....	26	
Spar-deck.	2 30-pdrs, No. 1; 12 30-pdrs., No. 4,	14	

(*Afloat and on the Stocks.*)

Gun-deck.	2 50-pdrs.; or 2 shell-guns of 22$^{cwt.}$, No. 2; 24 30-pdrs., No. 2.....	26	36 guns.
Spar-deck.	2 30-pdrs., No. 1; 8 30-pdrs., No. 4,	10	

SPAR-DECK SLOOPS.

(*New model.*)

Gun-deck.	2 Shell-guns of 22$^{cwt.}$ No. 2,.....		20 guns.
	2 30-pdrs., No. 2*; 14 30-pdrs., No. 3,	18	
Spar-deck.	2 30-pdrs., No. 1,.....	2	

CORVETTE À BATTERIE BARBETTE.

(*New model.*)

Spar-deck. 2 30-pdrs., No. 2; 14 30-pdrs., No. 3,.... 16 guns.

FIRST CLASS BRIGS.

(*New model.*)

Spar-deck. 12 30-pdrs., No. 4,..... 12 guns.

* These 4 pieces to be placed in the centre of the Battery

These regulations are directed to apply to all new ships and to those already built, so far as their construction permits, which not being practicable in all cases will account for the retention of some of the old calibres.

The following tables exhibit in a condensed form the style of Armament prescribed by the new Regulations:

1848.

	Rate of Ship.				Frigates.		
	1st.	2d.	3d.	4th.	1st.	2d.	3d class.
No. of 22cwt. Shell-guns,	16	16	16	16	4	4	2
No. of 30-pdrs. { Heavy,	24	24	22	20	26	24	0
No. of 30-pdrs. { Light,	76	56	48	40	30	22	38
	116	96	86	76	60	50	40
Proportion of Shell-guns,	1/7	1/6	1/5	1/5	1/15	1/13	1/19

1849.

	Rate of Ship.						Frigates		
			new.	old.	new.	old.			
	1st.	2d.	3d.	3d.	4th.	4th.	1st.	2d.	3d.
No. of 22cwt. Shell-guns,	10	10	10	8	8	4	2	2	2
No. of 50-pdrs., . . .	6	6	6	0	4	0	2	2	2
No. of 30-pdrs. { Heavy,	22	22	20	26	20	36	28	2	2
No. of 30-pdrs. { Light,	74	52	46	46	42	30	18	40	34
	112	90	82	80	74	70	50	66	40
Proportion of Shell-guns,	1/11	1/9	1/8	1/10	1/9	1/17	1/25	1/33	1/20

English Ship-Batteries.

Previously to the war of 1812, the long 32-pdr. predominated as the principal piece for the heaviest ships, and in frigates the long 18-pdr.

In 1825, Colonel Munro, of the royal artillery, presented to the Admiralty a memorandum detailing his plan of naval armament. He admitted but one calibre, the 32-pdr, in all batteries, of which there were to be different classes of weights, so as to adapt them to the several decks and rates of ships. These were the 25$^{cwt.}$, 42$^{cwt.}$ and 56$^{cwt.}$. A commencement seems to have been made in 1829, by casting a number of 32-pdrs., weighing 25$^{cwt.}$ and 48$^{cwt.}$, and was followed up in the next year by reaming out the 18 and 24-pdrs, of the Congreve and Bloomfield pattern, the weights of which were generally of 33$^{cwt.}$, 40$^{cwt.}$ and 41$^{cwt.}$.

To what extent the regular armament was altered by the introduction of these pieces into service, does not appear; but we learn from official documents,* that in 1837, the attention of the British authorities was drawn to the French decree of that year, which made the 30-pdr. the calibre of the fleet, with the addition of a small number of the Paixhans 80-pdr. or 22$^{cwt.}$, and that in consequence thereof, it was decided to reorganise the British naval batteries; which

* Parliamentary Committee, 1849.

was done in 1839 by adopting the one calibre 32-pdr. and its classes, recommended by Colonel Munro; adding thereto the 32-pdr. of 32$^{cwt.}$, 45$^{cwt.}$ and 50$^{cwt.}$,—in all, six classes. With these were combined the 8-in shell guns of 65$^{cwt.}$ and of 53$^{cwt.}$.

The casting of the new ordnance proceeded rapidly, so that in 1848 more than 8000 new and reamed 32-pdrs. were available, and about 1600 shell-guns.

These constituents, according to the British Aide Memoire, are arranged in the batteries as follows:

	Rate of Ship.				
	1st.	2d.	3d.	Razees.	Frigates.
Whole No. of guns.	110	92	80	50	50
No. of 8-in shell-guns,	10	10	12	6	4
32-pdrs. Heavy,	50	56	20	22	0
32-pdrs. Light,	50	26	48	22	46

United States Ship-Batteries.

The new ships built after the war of 1812, were armed as follows:

	Lower-deck.	Gun deck.	Spar deck.
Frigates,	———	32-pdrs.	42-pdrs.
Liners,	42-pdrs.	32-pdrs.	42-pdrs.

Forming a simple and powerful system of battery,—probably the best of its day.

In 1841, a few 8-in shell-guns (63$^{cwt.}$) were introduced, generally four on each gun-deck.

In 1845, a Board, convened for the purpose, adopted a system having the 32-pdr. as its unit-calibre, and added a certain number of light 8-in. shell-guns on the spar-deck to those already borne below.

The classes of the 32-pdrs. weighed severally 56$^{cwt.}$, 51$^{cwt.}$, 46$^{cwt.}$, 42$^{cwt.}$, 32$^{cwt.}$, and 27$^{cwt.}$. The shell-guns, 63$^{cwt.}$ and 55$^{cwt.}$, being almost identically the English system.

In 1853, it was directed in future equipment, that the light 8-in shell-guns (55$^{cwt.}$) should be excluded from the spar-decks of Frigates and Liners, and the number of 8-in of 63$^{cwt.}$ on each gun-deck increased, so as to form an entire division of ten pieces.

About the same time some of the older frigates were razeed, and received a larger complement of shell-guns.

Thus it appears, that the leading principle of

the present existing naval armaments is alike in the United States, England, and France.

The main element of ordnance power is represented by one calibre.—

—And that calibre is the 32*-pdr. or its equivalent the* 30*-pdr.*, the pieces differing in weight according to the vessel, or tier of battery where they are to be used: and the heaviest of the classes are similar in the three services, so far as offensive capacity is concerned.

No project has proved more attractive to naval men than that of having a uniform calibre throughout the entire fleet. It has been proposed from time to time without success, until adopted for the French navy in 1829.

In the promptness with which the example was followed by England and the United States, may be recognised the general convictions of the profession in regard to the serious mischief inseparable from the chaos of calibres that prevailed, and the urgent necessity for some measure that would simplify the complex economy of naval ordnance.

In a three-decker might be witnessed the extreme phase of the evil: long 32-pdrs., 18-pdrs., and carronades, requiring three sizes of shot and four classes of full charge, with as many reduces as caprice might suggest. All this variety of supply was to be distinguished and selected in the magazines and shot-lockers,—circulated with perfect exactness in the confusion and obscurity

of the lower passages, to a particular hatchway, then up to the deck where was placed the gun for which each charge or shot was designed: and this was to be accomplished not with the composure, deliberation and attention that the nature of the operation itself demanded, but amid all the excitement and hot haste of battle.

The utter impossibility of avoiding mistakes, and the mischievous consequences resulting from their commission at such a time, deeply impressed every thinking mind with the urgent necessity of some reform. The officers knew from daily experience, that simplicity of detail and arrangement was not only convenient in the affairs of their profession, but was an element of efficiency when celerity and certainty were to be attained by the joint action of masses of men. It was most natural, therefore, that whatever held out the promise of simplifying the complex system of batteries, should be most favorably received by common opinion.

There was no novelty in the project of a uniform calibre: it had often been discussed, and was familiar to most naval men,—it may be said, indeed, that they were prepared at the time to assent to its fullest development, and had proper use been made of the opportunity, there would have been experienced no resistance of any importance.

Unfortunately the remedy was but partial in its

character, and, like all temporising measures, only substituted one evil for another.

The cannon of the whole navy were to discharge shot of one size, and hence the service of the lockers became one of perfect simplicity.* But as the guns, though of one calibre, were to be of different weights, there remained all the diversity of charges, carriages, sponges, rammers and entire appliances that had previously prevailed, attended of course by the same troubles of equipment and of service.

By way of illustration, let us note the effect of the new and old systems on the battery of a U. S. first class frigate (Raritan and class,) built in 1820. The guns designed for such a ship were long 32-pdrs and 42-pdr. carronades; by the regulations of 1845, these were to be replaced by three classes of 32-pdrs, the long, the 51^{cwt} and the 32^{cwt}, for which no less than seven different charges were prescribed by regulation, varying from 4$^{lbs.}$ to 9$^{lbs.}$. This was certainly not a simplification,—it was a mere change in the character of the complication, being a choice between two sizes of shot with three charges on one hand, and one size of shot with seven charges on the other,—thereby abolishing the trouble at the shot locker, but in-

* In 1821, Paixhans proposed the 36-pdr. as the unit calibre of the French Navy; but he too designated no less than four classes of ordnance for the purpose.

creasing it in the magazine and the powder division, where by the way, it is most judicious to impose as little duty as possible of a responsible or discretionary kind,—the *personal* of that division being made up mostly of men whose usual vocation in a ship is not likely to give them any clear ideas of the importance of their occasional office at quarters, nor opportunities of improving their information in regard to it.

The complication of equipment was undiminished, perhaps even increased, by the new arrangement, for there were three different classes of appliance introduced with the three styles of 32-pdrs., in lieu of the two which existed previously,—and this evil, though of secondary importance, was still of great interest in many points of view.

The readiness with which the expense and trouble consequent on such a radical change in the armament of the large navies were met, makes it the subject of surprise and regret that the reform was not accepted and carried out in its fullest sense—which is obviously not only one calibre, BUT ONE GUN, FOR ALL DECKS AND FOR ALL SHIPS, to the lowest class whose dimensions render it admissible.

But even a graver objection existed to the adoption of the new system by at least two of the three powers. The calibre chosen as the standard detracted from the force of their heaviest ships' batteries.

The lower tiers of French vessels of the line were commonly constituted of the 36-pdr., which is nearly equivalent to our 42-pdr., and this piece necessarily made way, under the new order of things for the 30-pdr. It is true, that the force of the upper decks was improved by removing the 18-pdr. and 24-pdr. therefrom, and mounting the 30-pdrs. of corresponding weights in lieu of them.

But the melioration of the upper tiers, did not necessarily involve a sacrifice of the power of the lower battery. The 36-pdrs. might have been retained there, and 30-pdrs. substituted for the 18 and 24-pdrs., which would have increased the force of the ship and reduced the existing complication in a degree.

There was substantial ground then for the objections of the veteran officers who were opposed to the disuse of the 36-pdr., thus noticed by Col. Charpentier.

"Others again having witnessed the advan-
"tages of the 36-pdr., at a previous period, regret
"its abandonment, and are grieved to see it dis-
"placed by an inferior calibre, the power of
"which must be of less intensity, and they in-
"sist strongly on the restoration of the 36-pdr."
—(*Charpentier*, 31.)

The English authorities are not chargeable with having impaired the power of their batteries of the line by abolishing the heaviest ordnance, and taking a mean calibre as the unit.

On the contrary, they actually raised the standard of the heavy ships, by using the heaviest calibre they had. It is true, that the Memorandum of Colonel Munro, which was submitted to the Admiralty (1825) before the French began to remodel their ordnance, (1829,) argued for the adoption of the 32-pdr. calibre as the unit, on the ground that it was invested with sufficient power for all naval purposes; but whether this was the motive with the authorities for adhering to that calibre or not, the true principle was followed in taking the heaviest denomination of gun as the unit, retaining the 32-pdr. below, and substituting it in the upper batteries for the 18 and 24-pdrs.—thus abandoning their lighter calibres, while the French relinquished their commanding piece, the 36-pdr.; and in this way the lines-of-battle were equalized in calibre, obviously to the great advantage of the English, which previously were of inferior metal.

Admitting then the necessity of a uniform calibre in our own service, how was the principle to be developed with reference to existing ordnance?

The settled policy of the Republic forbade all attempt to rival with numbers the immense fleets of England and France. Wherefore the only hope of our Navy lay in the *individual excellence of its ships;* to assure which, it was indispensable to follow sound principles and carry them out to the least detail, omitting nothing, however

minute, that contributed to a perfect whole. Experience had shown what could be effected in this way, even with means that seemed insignificant,—and the commanders whose proud distinction it had been to sustain the flag with honor, coming fresh from the eventful conflict of 1812, gave significant indications of the value they attached to a proper ordnance, when called on in 1820 to determine the armament of the ships that were to be added to the Navy under the "Gradual Increase Act."

The frigates were to be armed with the long 32-pdr. below, and the 42-pdr. carronades above.

Ships-of-the-line had the same, with a tier of 42-pdrs. in the lowest battery. This, if not the most simple armament, was certainly less complicated than usual, and the most powerful of the kind at the time of its adoption.

The English might, without positive danger, disregard the advantages to be derived from a full compliance with a fundamental principle, however earnestly asserted by one of the ablest writers on ordnance,* for *the possible inferiority of individual ships could be compensated by numbers.* The French too might, if they would, sacrifice power in their naval batteries to some supposed equivalent, notwithstanding the maxims inculcated by their distinguished artillerist;† for the

* Simmons on Present Armament of Navy, 1839.

† Paixhans.

annihilation of her entire navy would not touch the source of the real power of France. But if these United States *would maintain past reputation and present rights*, they dare not organize their scanty national marine on any but the surest foundation.

When, therefore, it became requisite in 1845, to renovate our Naval system of Armament, it only remained to apply the general principle so well proved by past history. *The power of the Batteries was to be increased.* With existing calibres, this was only to be done by making the highest, (42-pdr.) the unit—withdrawing the long 32-pdrs. from the second deck of Liners, and gun-decks of Frigates, in order to substitute long 42-pdrs., but somewhat fewer, so as not to increase the weight of the Battery.

Now, however, the advent of a higher elemen of Ordnance power, overshadowing the pretensions of the 32-pdr. and the 42-pdr. equally, deprives the question of any practical value: though its consideration is still useful as involving an abstract principle which is applicable to all ordnance.

SHELL-GUNS.

The benefits that were to accrue from the long-sought and so recently attained unity of calibre, seemed doomed by some fatality never to be realized in their full extent, at least with the 32-pdr. and 30-pdr.; for just as the measures designed to give practical effect to the project were in course of execution, the shell-gun enforced admittance among Naval Ordnance, and thus marred the uniformity of the Unit Battery. For the authorities were equally unable to reject it wholly or to adopt it entirely—two calibres were therefore unavoidable.

At first, and for some time subsequently, the number of shell-guns introduced was very limited; too much so to exert any material influence on the absolute or relative values of the French, English, or United States' broadsides, but not to escape the habitual tendency to complication: for very soon there were two or more classes of the same calibre to be found in the three services. The French had Nos. 1, 2, and 3, of the 22$^{cwt.}$. The English, the 8$^{in.}$ of 65$^{cwt.}$ and of 52$^{cwt.}$. The United States, the 8$^{in.}$ of 63$^{cwt.}$ and of 55$^{cwt.}$.

The British Regulations of 1839, had practically the effect of fixing the minimum of the shell-power in their Naval Batteries; while special orders or Regulations made such addi-

tions from time to time in particular ships or classes, that in 1849, only ten years after the date of the General Regulation, it appears from official sources that 76 vessels were armed with a greater number of shell-guns than prescribed in 1839.

The total force of these ships was nearly 4000 cannon, of which about 1200 pieces (or $\frac{3}{10}^{ths}$ of the whole) were 8$^{in.}$ shell-guns; besides 45 pivot 68-pdrs. or 10$^{in.}$ shell-guns—being about twice the force of the whole U. S. Navy built or building. In some of the ships the shell-guns in broadside were so numerous as to be constituted into an entire tier: in others they were divided among the several tiers.

The following summary from the Report of the Select Committee (1849) of Parliament, exhibits the class of these vessels and the nature of their Batteries.*

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* It differs materially from the Armament of certain ships as given by Sir Howard Douglas—such as Ajax, Amphion, Eurotas, Trincomalee, Brilliant, Dædalus, &c.

Type of the class.	No. of the class.	Total No. of guns carried by each.	In each Ship. 32-pdr.	8-in. shell guns.	Pivot guns.	In all the Ships. 32-pdrs.	8-in. shell-guns.	Pivot guns.
Pique,	7	40	34	6	———	238	42	—
Amphion,	1	36	30	6	———	30	6	—
Brilliant,	2	20	14	6	———	28	12	—
Dædalus,	1	19	12	6	1 of 10in.	12	6	1
Portland,	9	50	42	8	———	378	72	—
Trincomalee	2	25	14	10	1 of 10in.	28	20	2
Vernon,	24	50	38	12	———	912	288	—
Arrogant,	1	46	32	12	2 of 68	32	12	2
Eurotas,	4	24	8	12	2 of 68 2 of 10in.	32	48	16
Rodney,	3	92	66	26	———	198	78	—
Albion,	7	90	64	26	———	448	182	—
Ajax,	4	60	28	26	2 of 68 4 of 10in.	112	104	24
Euryalus,	6	50	22	28	———	132	168	—
Emerald,	4	60	30	30	———	120	120	—
Prince Regent,	1	92	60	32	———	60	32	—
	76					2760	1190	45
							3995	

In 1853, some simplification of the U. S. Batteries was effected by abolishing the light 8in. guns and 32-pdrs. of 51cwt. in the spar-deck battery, and increasing the 8in. of 63cwt. on all gun-decks, so as to form an entire division there of 10 pieces. This materially improved the power of the ships.

In France alone, where originated the leading measures that have so entirely remodeled Naval Batteries, was there shown any tendency to keep

the number of shell-guns within very limited bounds. A slight diminution was even effected to make way for a new and very heavy gun in broadside, (the long 50-pdr. of 10,000$^{lbs.}$), which nearly assimilates with the Brititsh 56-pdr. in calibre and character.

The execution of this plan does not appear to have been carried out to any extent; not further, it is believed, than a trial of the gun in one or two ships; which is not surprising, considering that it was to be located in broadside, where its powers would be cramped by the size of the ports, and the want of a pivot-carriage sensibly experienced. The reasons are not given for this unusual application of a piece whose weight and range, according to the invariable practice of other Navies, were exclusively fitted for pivot service. Its peculiar powers of matching the British 56-pdr., or of supplying the obvious deficiency in range of the 22$^{cwt.}$ shell-gun, were plainly nullified by placing the gun in a port; for it is stated* by the commander† of the ship *Minerva*, that the muzzle of the 50-pdr. was in contact with the upper sill at 4½°, though the dimensions of the port had been purposely increased. Now the special function of such a piece hardly began until it reached this eleva-

* Inquiry into the condition of the French Navy, ordered by the National Assembly, 1849.

† Captain Degenès.

tion. It is true that the heel of the ship might add all that was required for the long range, if the gun was to windward, but in firing to leeward the same cause would take away even the limited scope allowed by the port.

Its introduction was therefore a disadvantage *under the circumstances*, for it displaced an equal number of the 22$^{cwt.}$ which, similarly situated, were more convenient of management and of greater power. Placed at the bow or stern on the spar-deck, its superior fire at long range would have been unquestioned and useful.

The operation of the several regulations and special orders on the armaments of French, English and United States ships at different periods, may be perceived by the following summary of the elements of force in the classes that represent the average power in the line-of-battle, and also in that ship of all work, the frigate.

LINE-OF-BATTLE-SHIPS.

	No. of guns.	Date.	Shell-guns 8in. or 22cent.	32-pdrs. long,	medium or light.		
British,.....	92	1839	10	56	26		
"	92	1849	32	34	26	0	Fr. Regent, &c.
"	92	1849	26	42	24	0	Rodney, &c.
French,.....	96	1848	16	24	26	30	
"	90	1849	10	22	28	24	80-pdrs. 6
United States,	88	1820	0	32 42-pdrs. 34 32-pdrs.	0	22	42-pdr. Carr.
" "	88	1841	8	28 42-pdrs. 30 32-pdrs.	0	22	
" "	84	1845	12	60	12	0	
" "	84	1853	20	48	16	0	
Suppo'd U.S.	84	1845	20	44 42-pdrs.	0	20	42-pdr. Carr.

FRIGATES, 1ST CLASS.

British,.....	50	1839	4		46		
"	50	1849	12	20	18	0	Vernon.
"	50	1849	28	0	22	0	Eurydice.
French,.....	60	1848	4	26	0	30	
"	50	1849	2	28	18	50-pdrs. 2	
United States,	54	1841	4	28	0	22	42 Carr.
" "	50	1845	8	30		12	
" "	50	1853	10	24		16	

LINE-OF-BATTLE-SHIPS.

	No of guns.	Date.	Broadsides. 8-in or 22-cwt. Weight.	Content of powder.	32-pdrs. weight. Long.	Med. or light.		Total.
British,.....	92	1839	255	12½lbs.	896	416		1567
"	92	1849	816	40 "	544	416		1776
"	92	1849	663	32½ "	672	384		1719
French,.....	96	1848	484	32½ "	402	958		1824
"	90	1849	303	20½ "	368	871	long 30-pdrs. 167	1712
United States,	88	1820		none.	1248	462		1710
" "	88	1841	204	8 "	1068	462		1734
" "	84	1845	306	12 "	960	192		1458
" "	84	1853	510	20 "	768	256		1534
Supposed U.S.	84	1845	510	20 "	924	420		1854

FRIGATES, 1ST CLASS.

British,.....	50	1839	102	5 lbs.	736			838
"	50	1849	306	15 "	320	288		914
"	50	1849	714	35 "	0	352		1066
French,.....	60	1848	121	8½ "	436	503		1060
"	50	1849	60	4 "	469	301	long 30-pdrs. 56	886
United States,	54	1841	102	4 "	448	462		1012
" "	50	1845	204	8 "	480	192		876
" "	50	1853	255	10 "	384	256		895

Such are the results arrived at by the naval authorities of the three countries, in regard to the preferable mode of developing the fullest ordnance power of the broadside. They concurred in all the primary constituents save one —using a like calibre and its classes, associated with an auxiliary shell-power, of which the French piece alone differed in its development from the English and American.

But, how variously do they combine the several elements?

The line-of-battle-ships referred to, are nearly of like size and capacity. There is a heavier class, the three-deckers, and also a smaller class of their own denomination; but these are the heaviest of the two-deckers, and may be assumed to represent the average strength of the Line of the three nations.

By the regulations of 1839, the British total weight of broadside is low, and the power in longer pieces not very full. Both of these imperfections are well rectified in such ships as were affected by the special orders of 1849.

The French 90 and 96 have a full total weight of broadside, but are notably deficient in the power of battering beyond short distances, by reason of the small number of pieces capable of this effect.

The original United States' battery (1820) is well provided with a full total weight of the broadside, and a great power of penetration,

range, &c., mainly due to the tier of long 42-pdrs. The introduction of the 8-in. guns in 1841, detracted nothing from either of these qualities. But the effect of the regulations of 1845, is singularly unfortunate, virtually emasculating the power of the ship, in every particular. The order of 1852, remedied this to some extent, but had the 42-pdr. been adopted as the unit, that order would have maintained our heavy two-deckers upon an equality with the heaviest of the English class.

The shell power in all the ships was originally low, and insufficient to exercise a decided effect upon the general fire of the Line. The same may be said of the French broadside, as constituted by order of 1849, while the shell power of the United States was much improved, and that of the British became quite respectable, by the orders issued subsequently to the General Regulations; particularly the Prince Regent class, where it is of a predominating character; and makes the battery more powerful than that of any United States or French two-decker.*

In the first class frigates there is also consider-

* It may be noted here, as a means of comparison with ships of a past date, that the Britannia, three-decker, on being laid up in 1806, after the battle of Trafalgar, in which she bore a part, returned 102 guns to store at Davenport; showing a broadside weight of metal equal to 1160lbs.—(*Official Report to Committee of Parliament.*)

able diversity of combination; but the British Euryalus class (of which there are twenty-four ships) is plainly the most powerful, by reason of the great extension of the shell power.

It is to be observed that these regulations have reference exclusively to sailing ships, in which the battery is confined to the broadside.

But the application of steam to national vessels, imposes the necessity of resorting to a different style of armament.

The earliest steamers were driven by the side-wheel, and so continued for many years later. This arrangement conflicted directly with the system of broadside armament, both as regarded the number of guns and their position.

In the first place, it was impossible to carry the customary proportion of pieces in a vessel of this description, because the steam power occupied so much of the space commonly allotted to stowing provisions and water, that the crew required for a full broadside, could not be provided for. Therefore, it was necessary to reduce the number of men, and as a consequence, the number of cannon; independently of which, the latter could not be accommodated in the broadside, because the huge wheels and their fixtures not only covered much of its extent, but they interfered with the training of those guns for which there was room.

But the disadvantages of the new motor did not end with diminishing seriously the offensive

power of the broadside; it also offered a large and vulnerable surface to the numerous cannon of the sailing ship, so that close combat became almost certainly disastrous to the side-wheel steamer.

Thus several conditions concurred in determining the style of battery suitable for side-wheel steamers.

But few pieces could be mounted, and these must concentrate the greatest possible power of offense at ranges where the broadside cannon would be deprived of much of their efficiency.

Hence, the heavy ordnance of ten and twelve thousand pounds, (56-pdrs. 68-pdrs, &c.) and the pivot system by which they were alone manageable.

The 10$^{inch.}$ shell-gun of 84$^{cwt.}$ appears to have been the first piece of ordnance expressly designed and cast in England for this purpose. (1831). It was carried by the smaller class of steamers first introduced into the British Navy, and subsequently by the larger side-wheel and screw vessels.

In 1841, a 56-pdr. by Monk was made for the Navy, and in 1844 and 1845, more than 50 pieces of the same kind. The 68-pdr. by Dundas was subjected to experiment in 1841, and in the five years following, more than 100 guns of similar description were cast. These two pieces were long heavy cannon of 11 and 12000$^{lbs.}$, and commonly known as shot guns.

The 68-pdr. soon obtained the preference over the 56-pdr., and appears to be adopted at this time as the principal pivot-gun of the British Navy.

In addition to the pivot-guns necessarily mounted on the spar-deck, the largest steamers had gun-decks, on which were mounted as many broadside pieces as could be carried, but by no means in sufficient numbers to match the armament of a sailing ship of like tonnage.

Some 20 years passed in laborious and costly experiment with the new motor. Its advantages were great in certainty and in speed, but in defiance of every suggestion that experience could furnish, and of every improvement in detail, it seemed utterly irreconcilable with the development of the full ordnance power, and even with the use of sails. If steam were applied, it was to be done to the prejudice of the offensive power, and of the less expensive motor,—it was the riddle of the day.

The problem was at last solved as it only could be solved,—not by perfecting details, for it was not a defect of detail,—but by going back to the first principle of propulsion, where the difficulty had its origin. The cumbrous paddle was dispensed with, and for it was substituted the screw. By this means, the broadside and the space between decks were once more free to the guns along the entire length; the action of

the screw was in complete harmony with that of the sails; they might be used independently or in connection, at pleasure, and thus the restoration of the old and cheap motor made it convenient to reduce the new and costly one to the functions of an auxiliary. Hence, a reduction of the size of engine and its restriction to limits that did not interfere materially with the room needed for the crew that were to man the broadside. And to complete the sum of its advantages, the screw was hidden beneath the water, where, with the engine, it was not more exposed to shot than the magazine.

Thus the propeller ship was not only equal to the sailing ship in every motive and offensive power possessed by the latter, but it had at disposal another means of movement even less vulnerable than masts, sails, and yards.

The final result, thus accepted, constituted steam as an auxiliary, and the pivot armament experienced a similar change in its character. With the side-wheel, it was the chief means of offense, but when the screw was introduced and with it the broadside was restored, the heavy pivot-guns were retained, though by their comparatively limited numbers they became a subordinate element in the broadside. Thus the British 91 gun ships, *Nile*, *Algiers*, and some of the screw frigates carry a 68-pdr. on the spar-deck. Others, such as the *Simoon* and *Termagant*, carry 2 of 68

and four of 10$^{inch.}$, with 12 and 18 long 32-pdrs. in broadside,—a powerful armament, though liable to the objection of three calibres among 18 and 24 guns, and by no means developing the power of which the metal is capable.

INCIDENTS OF THE WAR.

VIII.

INCIDENTS OF THE WAR.

Sinope.—Odessa.—Bomarsund.—Petropaulovski.—Sevastopol.—The Vladimir.—Sveaborg.—Kinburn.

THE contest just terminated, is the first that has been waged between any great maritime powers since shells and steam have become elements of naval warfare. As a natural consequence, its varied incidents will be closely scrutinised by professional men, in order to discover how far the theories and speculations which they advocate or oppose, may have been confirmed or confuted by the stern verities of battle.

The story of the time, however, has yet to find its NAPIER, and this may not be shortly, for the actors in the eventful drama are too recently from its thrilling scenes to be inclined to the sober duties of the chronicler.

Meanwhile, we are without any authentic statement save those of the official reports which, are mostly so scanty, as to be unintelligible if it were not for the brilliant sketches of the public correspondents, who have so graphically limned the general picture.

The absence of precise technical results, is a serious disadvantage in the present case, when

one feels almost compelled to refer to them under the persuasion that some illustration of the kind is indispensably necessary to any conclusion upon the subjects which have just been treated of.

In such a dilemma a European writer would be enabled to find some substitute in the personal narrative and opinions of those around him which, if at times to be received with qualification, are yet valuable as the origin of the tradition that for a while will fill the place of history.

Here, remote as we are from the actors and the scenes, no such resource is accessible. It is with some misgivings, therefore, that we ventured on the task, hoping to have the opportunity at some future day to correct unavoidable errors, and to obtain the technical data required.

SINOPE.

(From Russian official account.)

This affair (or disaster as Lord Clarendon terms it,) occurred near the close of 1853, and has been made memorable by its political rather than by its military consequences.

So far as the facts can be ascertained from the information that is before the public, they appear thus:—

War existed between Turkey and Russia, but without the degree of activity that indicated much earnestness in the parties. In November, a squadron of seven frigates, with some smaller vessels, were sent by the Turks into the Black Sea. The Russians allege that its object was to seize Souchum Kalè and to aid the Caucassians, then in rebellion.* Whether the squadron succeeded in this or in any other purpose, does not appear.† But while at anchor in the roads of Sinope, it was descried, on the 24th of November, by the Russian Admiral, then cruising with three liners, (*Marie, Tcheema, and Rotislaff,*) a steamer and a brig.

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* Report of Prince Menchikoff.

† The letter of the Emperor Napoleon to the Emperor Nicholas, (29th January, 1854,) says:—"it matters little to us whether "or not the Turks wished to convey munitions of war to the "Russian territories." The English declaration of war makes no mention of the battle of Sinope.

The next day a violent gale prevented him from approaching the port, but he despatched the steamer (*Bessarabia*) to Sevastopol to announce the news.

Upon this, three liners of 120 guns, the *Paris*, *Constantine* and *Tri Sviatitelee*, were sent under Rear Admiral Novosilsky to Sinope to join Vice Admiral Nachimoff.

After the steamer left, the latter took advantage of a fair wind to reconnoitre Sinope. He made out the Turkish squadron to consist of seven frigates, one sloop-of-war, two corvettes, two steamers and two transports, anchored along the shore in a line conforming to its semicircular configuration.

Five batteries were noticed on the land at different points near the Turkish ships.

On the night of the 27th, the Sevastopol division, under Novosilsky, joined that off Sinope.

On the next day, (28th) Vice Admiral Nachimoff made signal that he would attack in two lines as soon as the wind permitted.

On the 30th, between 9 and 10 A. M., a fair breeze from E. N. E. sprang up,—the Vice Admiral made signal to clear for action and bear up for the roads of Sinope.

The ships were formed in two lines, under the two Admirals. In the right, were the *Marie* (flag,) *Constantine* and *Tschesma*. In the left, were the *Paris*, *Tri Sviatitelee* and *Rotislaff* two frigates remaining outside.

The Russian ships bore down under all steering-sails, but the Turkish vessels were so obscured by the fog and rain, that they were not seen until about half a mile distant.

When the Vice Admiral, in the *Marie*, was 500 yards from two of the frigates (one of which bore the Admiral's flag,) he anchored with a spring on. The Rear Admiral (in the *Paris*) and the other ships did likewise on coming into the positions assigned them.

The Admiral's anchor was scarcely down, when the Turkish squadron and shore batteries opened fire on the Russian ships, with considerable damage to their spars.

This was soon returned, and with such effect, that in five minutes the *Constantine* silenced the battery under her guns, and blew up with shells the frigate near it. Soon after, the shells from the *Paris* blew up another frigate, and in an hour the fire of the Turkish squadron began to slacken. At 2 P. M. it ceased entirely.

Three frigates, one of them the Admiral's, were in flames, and the two transports were sunk. The Turkish part of the town was also on fire in two places.

At 2½ P. M., the Russian Admiral made signal to cease firing. The two frigates which had been left outside to cut off any of the enemy that attempted to escape, came in towards the end of the action and attacked the corvette and sloop-of-war astern of the *Rodislaff*.

About noon, three Russian steamers, (*Odessa*, *Crimea*, and *Chersonesus*,) under Korniloff, coming from Sevastopol, which they left the day before, descried a Turkish steamer (the *Taif*) off Cape Sinope. This vessel had escaped while the conflict was going on. The *Odessa* chased and opened fire, but hauled off on finding the *Taif* was the faster.

When the steamers entered the Roads of Sinope, two of them were ordered to tow the two Liners lying under the shore batteries, and the other to take possession of the *Damietta*.

In the evening, the flames in the burning ships reached their magazines, and they blew up, setting fire to the town.

Next morning, the *Damietta* was set on fire, being too much damaged to reach Sevastopol,—also the corvette and sloop-of-war. In the latter were found the Turkish Admiral, and some officers and seamen, who were removed.

The Russian ships suffered chiefly in their spars and rigging; the *Marie*, *Tri-Sviatitelee*, *Constantine* and *Rotislaff*, the most. They weighed anchor on the 2d, the damaged ships in tow of the steamers; and on the 4th, the *Marie*, *Tri-Sviatitelee* and *Constantine* anchored in Sevastopol. The Russian loss was 34 killed and 230 wounded.

The celebrity which attaches to this action, is due rather to its political than military importance,—for it certainly was of no great moment, in the issues then pending between great powers,

whether or not Russia prevented Turkey from furnishing the Caucassians with the supplies that could be carried by a small squadron; and as little whether Turkey lost so much of her naval force.

It was a link, however, in that chain of grand political events that gradually drifted the principal powers into a struggle,—being the assumed basis whereon the Allies predicated the necessity of ordering their fleets into the Black Sea, for the avowed purpose of confining the Russian fleet to its harbors, and preventing its further aggression on the Turks.

As a military measure, the operation is remarkable for its completeness. It is true, the means were most ample,—but they were also fully applied,—the Turkish squadron being utterly crushed in a short time, the batteries silenced, and, unfortunately, part of the town destroyed.

Perhaps there is not on record another instance where a whole squadron of frigates was so nearly annihilated in so short a time, whatever may have been the difference in force,—the final catastrophe being generally averted by the submission of the inferior party.

So far as a judgment can be formed upon the leading incidents of this affair, as stated by the Russian Report, and hitherto not questioned by official statement on the other side, the plan of action was judicious, its execution prompt, not

marred by accident or misapprehension, and the ships of the attacking force well handled. To come to an anchor with heavy ships under a press of sail, the view so obscured by rain and mist that the enemy was not seen until within some 800 or 900 yards; clew up and anchor at good range and in regular order; instantly replace the springs shot away, and then open a well-directed fire,—may not be an extraordinary feat for good seamen, but it cannot be executed by indifferent hands.

On the side of the Turks, the errors were obvious and fatal to the entire squadron. Their Admiral knew well that only 42 leagues intervened between Sinope and the head-quarters of the Russian fleet, a distance so short that the Turkish squadron may be said to have been continually menaced by the presence of a most superior force, belonging to the nation against whom his Sultan had declared and was waging war at the time, and while his own ships were engaged in a hostile operation. Yet in view of this imminent hazard, the Turkish commander lay quietly and unconcernedly at his anchors, as if no dangers were to be apprehended. Under the circumstances, a single cruiser seaward was but an ordinary precaution, and would have warned him in season of the vicinity of the Russian squadron on the 24th, so that some of his vessels might have an opportunity of escape. Such negligence would be incredible, if it were not in keeping

with the usual improvidence of the Turkish proceedings.

Having thus utterly disregarded the peril that was so near at hand, and even shut his eyes to its approach, the Pacha met it like a desperate fatalist, and, without hesitation, madly began and maintained a contest which was without hope or object, and therefore a sheer waste of life.

The presence of the batteries probably alone prevented the Russians from accomplishing what they did, with entire impunity: for two of the Turkish frigates were blown up in fifteen minutes, and it is hardly probable that the remainder, with no heavier metal than 24-pdrs., and much of it below that calibre, could have done so much damage in a couple of hours to six Liners, as to cripple four of them, and disable 264 men, being a greater loss than the French fleet sustained at Sevastopol the October following.

It seems probable that the slackening of the Turkish fire, noticed as occurring after it had been sustained for an hour, proceeded from the cessation of the ships' batteries, and that the works ashore continued a feeble return to the Russians until about 2 P. M., when they were entirely disabled. It will be perceived too, that the Russians took precautions against the renewal of their fire.

We have no precise knowledge of the armament of the Russian ships, though we know that shell-guns formed a part thereof. General Paix-

hans, in his remarks on the action,* says, the Turks had none, nor any calibre heavier than 24-pdrs., and but few of these. The shore batteries were weak, and armed with guns of very small calibre.

It is also stated, on his authority, that the Turkish officers, on being asked as to the effect of the shells, were unanimously of the opinion that they caused the conflagration of most of the ships.

The only Turkish frigate afloat after the action (*Damietta*) had seventeen shot holes below water, and could not be got over to Sevastopol.

The two Admirals, Nachimoff† and Novosilsky, with Gen. Korniloff,† received Orders. The Captains of the *Paris*, (Istomine,†) and of the *Rotislaff*, (Konznetsoff,) were made Admirals. The Captains of the *Marie* and *Constantine* promoted; also those of the two frigates and two steamers. The Captains of the *Tri-Sviatitelee* and of the steamer *Crimea*, received Orders and the crews were also rewarded in some way.

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* *Moniteur*, February 21, 1854.

† Killed subsequently during the Siege of Sevastopol.

ODESSA.

(Odessa cannonaded by the Allied Fleets, April 22, 1854.*)

The English declaration of war reached the fleet at Varna on the 6th of April,—upon which the steamer *Furious* was sent to Odessa, under a flag of truce, to bring off the British Consul at that place. Arriving there on the 8th, and nearing the port, two blank rounds were fired, when the steamer stopped and sent a boat ashore with a flag of truce. While returning to the steamer, and about a mile from the shore, several shot were fired from the battery.

On the 14th a demand for explanation of the insult to the flag of truce was sent to Odessa, followed by the allied fleet, which, after a passage of three days from Kavarna, arrived at Odessa on the 20th, where the answer from the Governor of the place was received next day, denying any intention of firing at the boat, and asserting that the *Furious* was in motion, approaching the shore, and that the shots were fired to warn her to keep off. On the contrary, the English Captain states that the wheels never turned after the two blank rounds were fired, and that the head of his vessel was seaward.

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* From general official accounts of English and French Admirals, Russian General, and letters of Correspondents.

The Admirals refused to credit the explanation of the Governor, re-asserted the charge of violating a flag of truce and demanded, before sunset of the 21st, the surrender of all English, French and Russian vessels anchored at Odessa, as a reparation for the insult,—otherwise they menaced the Governor with a resort to force. This letter was received about 4 P. M., of the 21st, and was not answered by the Governor.

The Port of Odessa is entirely artificial, and formed by two moles running out seaward from the shore, which has a direction nearly N. W. by N. with a very slight bend from a right line. The beach is low and skirts a range of bluffs, said to be 80 feet high. These are crowned by some public and private buildings, the town stretching still further in, and partially seen from the sea. Below the cliffs along the beach, are the Lazaretto and other establishments connected with the trade of the place.

The two moles jut right out from the shore, and have an elbow inclining to the northward; so that they inclose, as it were, sufficient water for sheltering ships from the easterly and southeast winds. The northern, called the Crown or Pratique Mole, is 412 yards long. At its extremity is the Battery No. 6, which became the immediate subject of attack on the 22nd. About 1660 yards, or nearly a mile south of the Crown Mole, is the Quarantine Mole, which is 576 yards long. The port can hold 300 vessels,

and the bay is extensive, with a depth of water quite sufficient for the largest ships.

The military Governor, General Osten-Sacken, says that the sea defences consisted of six batteries, mounting in all 48 guns. Their positions are not given by him, and all that is said of them is, that the first is the most southwardly, and the sixth the most northwardly, being at the end of the Crown Mole or Pratique Port; also that the fourth and fifth were the most distant from the attacking vessels,—too far to act. The five batteries not immediately engaged, mounted 6 mortars of 96,—8 guns of 48,—22 guns of 24,—2 howitzers of 48, and 6 howitzers of 24,—in all 44 pieces. The Battery No. 6, had four 24-pdr. howitzers.

The attack was not to be made by the Line-of-battle-ships, but by the Steamers, which were to take position north of the Crown Mole, some 2000 yards distant. In this way, all the batteries on or about the southern mole, would be thrown out of play, being perhaps two miles distant, a range beyond the effective play of the heaviest metal of the Russians, the 48-pdrs., while the howitzers and 24-pdrs. were absolutely useless.

The nearest Battery, No. 6, having only 24-pdrs., was not calculated to injure vessels 2000 yards distant, while their long and heavy 56 and 68-pdrs. and 10-inch shell-guns would tell powerfully.

SHIPS OF THE COMBINED ENGLISH AND FRENCH FLEETS PRESENT AT THE CANNONADING OF ODESSA.

ENGLISH.		FRENCH.	
Britannia, (*Flag,*)	120	Ville de Paris, (*Flag,*)	120
Trafalgar,	120	Valmy,	120
Queen,	116	Friedland,	120
Albion,	90	Henri IV.,	100
London,	90	Jupiter,	90
Rodney,	90	Bayard,	90
Agamemnon, (*screw,*)	90	Jena,	90
Vengeance,	50	Charlemagne,	90
Sanspareil, (*screw,*)	81	Marengo,	80
Bellerophon,	78	Descartes,	20
Arethusa,	50	Vauban,	20
Retribution,	28	Mogador,	8
Terrible,	21	Caton,	4
Highflyer, (*screw,*)	21		
Furious,	16		
Tiger,	16		
Samson,	6		

English.—10 Ships-of-the-Line, 1 Frigate, and 6 Steamers, = 1117 guns.

French.—9 Liners and 4 Steamers = 952 guns.

The British and French ships had anchored about three or three and a half miles eastward of Odessa; the wind was fresh from S. S. W. to S. and S. E.,—moderate sea.

At 5 o'clock, signal from Admirals for steamers to stand in. The first division of steamers, *Vauban*, *Descartes* and *Tiger*, led by the *Samson*, passed the southernmost batteries, keeping out of range of them, and steering in for a position off the Imperial Mole. This division was followed at $6^{h.}$ $45^{min.}$ by the second division, and by the Screw-ships *Sanspareil* and *Highflyer*, ordered, however, to remain out of action for the present.

At $6^{h.}$ $36^{min.}$, the *Samson*, in passing the Battery No. 6, on the end of the Imperial Mole, which was to be attacked, fired the first shot, and this was instantly returned, the shot going through the quarter-boat, and finally dropping on deck; distance nine to ten cables' length.* Followed by the three other steamers, the *Samson* wheeled around, and in passing, again fired, the Russian shot hulling her repeatedly, but without much force. Perceiving that he was going near a buoy, placed by the Russians to mark their range, the commander of the *Samson*, and the division, edged off to a position where the guns of the battery would not bear or reach, and from thence poured in their fire

* French,—say about 1900 to 2100 yards.

steadily. The *Vauban* had received some hot shot while circling the Russian buoy, which ignited her side, and, being unable to suppress the flame, was obliged at 8 o'clock to haul out of action and return to the fleet for the necessary assistance.

At $8^{h.}$ $15^{min.}$, the *Arethusa* frigate was ordered to fire at some of the southern batteries, the guns of which were troublesome; which she did under sail, and was obliged to reef while so doing, as the breeze freshened.

At $9^{h.}$ $22^{min.}$, the second division (*Mogador*, *Terrible*, *Furious* and *Retribution*,) ordered into action,—began to fire about $10^{h.}$ $30^{min.}$, having anchored,—the first division also anchored.

The efforts of these seven steamers, aided during the absence of the *Vauban* by another French steamer, the *Caton*,* were mainly directed to demolish the battery on the Imperial Mole, the resistance of which was merely passive, for its few pieces were altogether unequal to the distances preserved by the steamers; and one of these was dismounted in the course of the morning. The question, therefore, was one of endurance only. When a favorable opportunity seemed to offer, the batteries on the cliffs opened fire, but with little or no effect, being too distant.

As the mole and the battery gradually gave way before the incessant play of shot and shells

* Intended to act as a repeating vessel.

and the fire of the battery itself began to slacken, the launches of the fleet pulled to the northward of the mole, and commenced to throw rockets among the Russian shipping. At noon the *Vauban* returned to her station, and joined in the cannonading. Soon afterwards, the flames were seen among the vessels lying in the mole; and the battery at its extreme, which had been nearly silenced, was abandoned, having been most gallantly maintained for six hours under the fire of eight steamers, without the least power of return.

At $12^{h.}$ $45^{min.}$ the conflagration was spreading along the mole, and in five minutes afterwards, the Magazine blew up* with a tremendous explosion. This catastrophe terminated even the show of defence at the point attacked, and nothing now remained but to destroy at leisure whatever might be accessible to the shot, shells and rockets of the allies. Accordingly, the steamers approached closer to the Imperial Mole, by which the distance to the Southern Mole was lessened, and excited a renewal of the fire from the guns on the Southern Mole, as well as of the mortars on the heights,—none of which proved effective.

About half past two, the Rocket Boats having got in too close to the northern beach, were suddenly opened on by a battery of field guns, which came out from under cover. The shot fell very

* It is said by an 8-inch shell from the *Retribution*.

near them, but hurt no one, and before the aim could be corrected, the steamers turned their shells upon the field-guns and drove them off, setting fire to some buildings that were near.

By 4 h. 30 min. all the Russian vessels in the mole were burning;—

—And at 5, P. M., the Admirals ordered their vessels to retire.

The plan of operations, stated to have been contemplated by the allies, appears to have been fully carried out; and by keeping out of reach of the Russian metal, though within the play of their own heavier cannon, the object was accomplished with the most trifling damage to the steamers. This became obvious to both parties as soon as the action was fairly entered upon. The Russian General says in his Bulletin:—"The enemy, taking advantage of the heavy "calibre of his guns, and particularly of his "Paixhans of 68 and 96, kept for the most part "out of range." The French Admiral in his official Report, says:—"The calibre of our guns "was larger than that of the enemy's battery, "and our aim better than theirs:"—"Such a "result attests the immense superiority of calibre "and precision of firing from our steam frigates "over those of the enemy."

The extent of loss on both sides fully confirms these statements. It is also noticeable that, when the *Samson* was hulled repeatedly by unconsciously trespassing too near the buoy marking the Russian range, the shot that struck seemed almost spent; the one, for instance, that passed through the thin sides of the quarter-boat, and knocked off a corner of wood work,—struck a man without injuring him, and then dropped down. The hot shot that set fire to the Vauban passed through the outer plank, and, being able to get no farther, rolled down between the frames; it proved very dangerous, notwithstanding its want of force. All of them must have struck direct, as the water was too rough for a distant ricochet.

It seems surprising that six hours were required to beat down the mole and its battery; if that battery had been able to make a return from corresponding metal, could the steamers have endured that return for six hours?

It was a great mistake to leave undefended the position taken by the steamers. Four heavy cannon on the mole, and a few more upon some work ashore, north of the mole, would have driven the steamers out of all range very speedily. It may be, that this part of the Roads was deemed impracticable to the approach of war vessels of ordinary draught, as the water is much shoaler there than off other parts of the town. A passage in General Osten-Sacken's

"Order of the Day," seems to indicate such an expectation:—"The hostile steamers being built "of iron, and drawing very little water, were "able, in spite of opposition, to round the mole "and approach the bank,—one of them going "toward the suburb of Perecipe, accompanied "by boats, from which they threw Congreve "Rockets, which burned the vessels in the Pra- "tique Port and the houses in the suburb."

BOMARSUND,*

Is situated on the principal island of a very extensive cluster that occupies a commanding position between the waters of the Baltic and the Gulf of Bothnia, approaching to thirty miles of the Swedish coast. Its fortifications may be said to menace Stockholm itself, and would therefore be of the first importance in the event of hostilities between Russia and Sweden.

In June (21st) three English steamers, under Captain Hall, had cannonaded the works erected to control the anchorage of Aland. It was late when they opened fire, which was continued vigorously until midnight, favored by the protracted light of the day in those high northern latitudes. Though one of the steamers nearly exhausted her supply of shells, there is reason to believe that the distance was entirely too great (perhaps 2000 yards) for effect.† The vessels had five men wounded.

It is probable that the warmest part of the affair was with a small water battery, mounting four field pieces, and supported by a body of

* From an account published by General Niel, (commanding French Engineers,) with the concurrence of Colonel Rochebouet, commanding the Artillery, and sanctioned by the Minister of War.

† The main-deck guns could not be used,—only the 10-inch and similar cannon.

Finnish riflemen. These galled the assailants exceedingly until finally driven away by the fire of the heavier guns from the steamers.

Subsequently, the Allies deeming that these works were too strong to be attacked by sea alone,* resolved on reducing them by regular siege operations; and with this object, a corps of 10,000 French soldiers was embarked in the latter part of July, under General D'Hilliers.

The forts on Bomarsund were reconnoitred on the 1st of August by the General, the Admirals Napier and Parseval, with the Generals of Engineers, Niel and Jones, in a small English steamer.

The principal work commands the anchorage and passages immediately bordering on its site. It stands near the water's edge, is very large, and has the form of a demi-ellipse, the larger axis of which measures 950 feet. It has two tiers of casemates, each pierced with 62 embrasures on the curved face, which is turned seaward, and is 6.4 feet thick.

The exterior facing of all the casemates is composed of large blocks of granite, in form nearly pentagonal.

The whole masonry has been executed with the greatest care, and must be considered as of very good quality.

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* Admiral Napier, in the course of a speech at the Lord Mayor's banquet, (November, 1854,) asserted that he desired, and had proposed to the British Government, to make the attack himself without the aid of the French corps.

The gorge, though closed, relies mainly for defence on three round towers placed in different directions, at distances of 880 and 980 yards. One (A) to the north, at the extreme of a small peninsula,—another, (B,) to the south-west, on an elevated site, whence it commands the redoubt, and the ground within range. A third, near the water's edge, on a point of the adjoining isle of Prasto.

The three are similar, having a diameter of 47 feet; are well and solidly built upon the bare and rugged granite; are pierced with 29 casemated embrasures in two tiers, and loop-holed at the interior spaces.

On the 7th of August, the ships with the troops arrived before Bomarsund, and anchored just out of cannon shot; next day, a landing was effected without resistance at different points a few miles from the forts, and the investiture completed landward, but not seaward, as Prasto was unoccupied and thereby some communication was still practicable.

On the night of the 9th, the commandants of artillery and engineers concluded the examinations begun by day, and decided the western tower to be the key of the position, and therefore to be reduced first.

After some consultation among the chiefs of the forces, the General resolved that the French should establish a battery (No. 1) of four 16-pdrs. and four mortars at 650 yards from the west

tower (B), and the English another, (No. 2,) of four naval 32-pdrs. of 42$^{cwt.}$ at 440 yards, or if possible at 330 yards, against the same tower. Should these prove insufficient, the French to place a third, (No. 3,) at 220 yards, armed with long ship 32-pdrs.

Early on the 13th August, (4½ A. M.,) No. 1 being completed, opened conformably to the plan. The Russian return was good, and three French pieces were struck, but the battery soon acquired the ascendancy. At first its shot were broken against the granite; but this finally gave way. It now appeared that the English battery could not be brought nearer the tower than 650 yards; wherefore, the French established No. 3, on the night of the 13th.

Next morning, the guns of the tower being silent, and the garrison seemingly much diminished, some chasseurs entered an embrasure and seized the commandant with 32 men, the rest of the garrison (140 in number) having escaped to the main work.

The 16-pdrs. of No. 1, fired 350 shot in 14 hours. In the same time the four mortars threw 240 bombs.

When the Russians perceived the capture of the western tower, they threw bombs into it from the other works, which hurt some men, and produced such quantities of splinters from the masonry, that the French were obliged to leave it; and soon after had to draw off further,

as the fire broke out and threatened an explosion.

The capture of the west tower ensured the command from that quarter; but the site of the battery for breaching the grand redoubt, being taken in reverse by the north tower, (B,) the English battery was directed that way; and during its operation, the French were to establish the breaching battery, and then be assisted by the English battery, which, by that time, would have reduced the north tower.

During the evening of this day, a few of the ships fired single shells deliberately at the fort, which were returned in like manner,—this lasted but a short time, and was probably without consequence to either party.

On the 15th, the besiegers opened a general fire on the Russian works. The English battery upon the north tower from the three 32-pdrs. of 42 cwt, manned by seamen and marine artillerymen. The French from No. 4, (armed with four mortars and two howitzers,) playing upon the gorge of the principal work, also from two of their new style of field pieces, placed at 880 yards,—and the ships with their heavy guns, at a range of 3000 yards.

The 10-inch shell-gun of 84 cwt had also been landed from the *Blenheim*, and placed at 1800 yards from the fort, behind an earthen rampart, 16 feet thick, 9 feet high and 35 feet long, thrown up by the seamen of the ship. The

Captain, (Pelham,) who took charge of the piece himself, opened in concert with the other batteries.

The Russians replied steadily to all. The north tower to the English battery, with plenty of round and grape at the French battery, No. 4, which also was fired on from the gorge. The *Blenheim's* 10-inch shell-gun, as well as the ships, had a share of shot, shell, &c., from the fort; the fire of the vessels was lively,* and the fort must have suffered seriously from it, had the distance not been so great: but on this account some of the shells fell outside of the walls, and the Russians also injured the embrasures by giving the guns the elevation due to the range, (3000 yards.)

The French chasseurs meanwhile endeavored to quell the fire of the Finnish riflemen, which was proving very troublesome, as it had done previously to the three steamers in June.

While the cannonade was going on, the western tower, which had continued burning, blew up and was entirely destroyed.

In the evening, the north tower showed a white flag,—a complete breach had been made from top to bottom, between the two embrasures, and would have been easily made practicable if widened a little at the foot. This had been

* The French Engineer noticed particularly the great range and accuracy of 80-pdr. shot from the steamer of Admiral Chads.

effected by 487 shot and 45 shells, fired from the three 32-pdrs. of 42 cwt. in eight hours, (22 rounds per hour each gun); the charge of gun 6 lbs., distance 950 yards.

The skill and intrepidity of the Russian gunners were worthy of remark. They damaged the three 32-pdrs., and after the fall of the masonry, continued to serve their guns, though entirely exposed.

The principal exterior defences of the gorge being now reduced, haste was made during the night to establish a breaching battery at 440 yards; and Admiral Parseval occupied the isle of Prasto with marine infantry,—so that the place was now completely invested.

On the 16th, the fire of mortars and howitzers was maintained continually from No. 4, and the chasseurs annoyed the defence considerably; but nevertheless many of the French soldiers were wounded.

Admiral Napier, observing that the Prasto tower was harassing the English battery No. 2, ordered a squadron of steamers, *Hecla*, *Leopard*, and *Cocyte*, under Rear Admiral Plumridge, to cannonade the tower; but, after the surrender, it appeared with no other damage than to the roof and guns *en barbette*, two of which were disabled,—the masonry and bomb-proofs were unhurt, and five men killed or wounded.

In the afternoon, the white flag was displayed on the fort, whither repaired the Admirals and

Generals; the French battalions entered the Court, and to conclude, the commander of the Prasto Tower, on being summoned, surrendered with a garrison of 140 men and 18 guns.

The battery No. 4, in operation during the 15th and on the 16th until the capitulation, had thrown 230 shells and 300 bombs from the two Howitzers and four Mortars, the former served by the land Artillery, the latter by the marine Artillery.

The Governor, General Bodisco, stated that the surrender had been particularly brought about by the appearance of the breaching battery, so rapidly raised in the night against the Gorge. On the other hand the Allies were struck by the preparations made for receiving the assault.

All the openings looking upon the Court had been barricaded by timber and bags of meal, leaving no apertures but those for the musketry. Had the garrison sustained an assault, the French Engineer thought the assailants would have suffered great losses, but states that the Russians must have been *aware of their fate*, if the French soldiers had been compelled to carry the work by force.

The number of the garrison was 2400 men. There were mounted in the Fort and Towers, 116 guns, mostly 32-pdrs., and three mortars. 78 Swedish cannon were in the park, and 7 field-pieces in the Court ready for service: a consider-

able stock of powder, projectiles, and provisions were on hand. The besiegers lost 85 killed and wounded.

The French Engineer, General Niel, remarks that as the masonry of the works was not covered at any part by earth, it is manifest that the whole plan of defence was based on the supposition that the large blocks of granite with which the exterior walls were faced, would resist the action of cannon.

But the defenders of Bomarsund must have experienced a great disappointment, when they found that 16-pdr. shot and bombs were able to dislocate so completely the masonry of the West tower, and the 32-pdr. shot to breach the North tower at more than 950 yards.

He remarks further, that the siege of Bomarsund is another proof of what has always been admitted in France, that masonry of any quality, cannot withstand the effect of heavy calibres at good range; and the circular form, which necessarily tends to divergent fire, likewise gives most advantage to the attack.

The next operation of the Expeditionary Corps would have been directed to Hango, where the two forts, Gustavarn and Gustaf Adolph with some marine batteries, command the passage from the Gulfs of Bothnia and Finland. But the Russians foreseeing that these could not be maintained against the Allies, blew them up on the 27th of August, while the Admirals and Ge-

nerals were reconnoitering the position, and thus terminated the only operations which were within the scope of the Expedition in the Baltic.

It is stated by General Niel, the French Engineer, that when it was decided to destroy the works, the English Naval officers requested that six casemates should be left standing, in order to try the effect of shot on masonry faced with granite.

A ship of the line was anchored 1000 yards (915 metres) from the wall of the casemates, and fired two hours with single shot and in volleys. The shot had little effect on the masonry.

The ship then approached to 500 yards (458 metres) and opened a well sustained fire, firing by broadsides from the two decks: in an hour's firing the walls fell in ruins.

At this last distance, the first shot was fired only 24 minutes after letting go the anchor, and the opinions of Admiral Napier, the English Naval officers, and General Jones were, that a similar operation would not have been practicable under the enemy's fire;* the ship and her crew would have suffered too much.

* In expressing this opinion, neither of these officers could have entertained the idea that a well disciplined ship must need 24 minutes to open fire.

Sir Howard Douglas says, (376,) "The firing "of the *Edinburgh* at 1060 yards *was unsatisfac-* "*tory.* 390 shot and shells were fired from the "largest and most powerful guns in the British "Navy, (viz:—from the Lancaster gun of 95$^{cwt.}$ "with an elongated shell of 100 lbs.; from "68-pdrs. of 95$^{cwt.}$ and 32-pdrs. of 56$^{cwt.}$ solid "shot guns; from the 10-in. shell-guns of 84$^{cwt.}$ "with hollow shot of 84 lbs.; from 8-in. shell-"guns of 65$^{cwt.}$ and 60$^{cwt.}$, with hollow shot of "56 lbs.), but did little injury to the works. At "480 yards, 250 shot, shells and hollow shot "were fired; a small breach was formed in the "facing of the outer wall, of extremely bad "masonry, and considerable damage done to the "embrasures and other portions of the wall; but "no decisive result was obtained,—no practicable "breach formed by which the work might be "assaulted; &c., &c."

Attack on Petropaulski,

August 31st and September 4th, 1854.

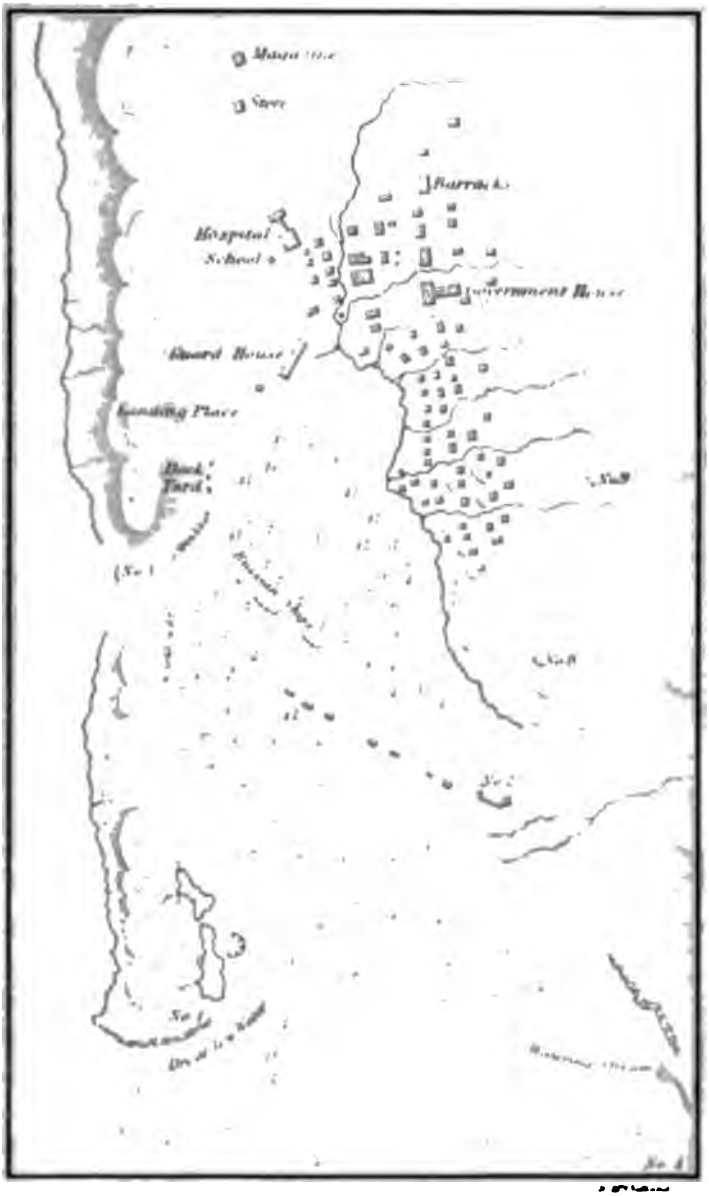
(From English accounts.)

The statements which have reached here in relation to this affair, are so scanty and obscure as to make it difficult to obtain any precise idea of its details. We have, therefore, to be content with a mere outline of the circumstances under which the combat was conducted.

Awatska bay is situated on the eastern shore of the Kamskatka peninsula, and towards its southern extreme. It is rather a harbor than a bay, in the ordinary sense of the term,—being a spacious basin nearly circular in figure, some 10 miles across, north and south, and rather less east and west, and enclosed on all sides, having an entrance at the S. E. angle nearly 1½ miles wide and the same in length,—the shores well defined and the channel easily distinguished. This extensive harbor is encircled by lofty mountains, and contains within it three smaller harbors, Tareinski on the S. W. corner,—Rakovya on the eastern shore, and some two miles more northerly on the same side, that of Petropaulski. The two first are quite large, while the last named is very small, but of convenient dimension, good depth of water, easy of access

PETROPAULSKI

From Survey by Capt. Beechey, 1827



Scale in Fathoms

and of defence. It is formed by the jutting due south from the main shore of a high tongue of land about ¾ of a miles long, (Signal Hill,) running nearly parallel with the direction of the main coast opposite, and forming a little harbor from 500 to 600 yards in width, which is divided into two ports by a low spit of sand, that starts from the main shore and making out obliquely some 500 yards towards the middle of the long tongue of land, approaches it so closely as to leave a passage of but 80 yards wide, whereby the entrance to the upper port is effected, the channel varying from 5 to 9 fathoms.

There is a sufficient depth of water in all parts, and the navigation is free from rocks or other obstructions. A small town containing three or four thousand people, is located at the head of the inner port on the slopes of the hills which rise from the margin of the water; and fishing huts are scattered along the sand spit.

Considering the remoteness of the region, and the little value of the place in a military or commercial point of view, it was amply fortified; several batteries being posted on different points so as to command the approaches and various parts of the ports,—not armed with many cannon, nor very strongly constructed, but as well combined as the nature of the ground permitted, and quite sufficient to defend the place against an attack not conducted in full force.

The tongue of land that encloses the port to

the westward, and separates it from Awatska Bay, rises abruptly from the water into a promontory of considerable elevation, called *Signal Hill*, that extends northward about half a mile from its cape, and then terminates suddenly, leaving a low sandy isthmus between it and the continuation of the highland, (Nicholas Hill,) which stretches onward upon the main land, and still continues to border the shore of the bay,—both hills being covered by a thick growth of wood.

The narrow pass between these ridges is the site of a monument erected by the Russians to La Perouse, and is closed by a Battery, (No. 3,) directly facing the bay.

Just at the northern limit of Nicholas Hill, and close to the water is a Battery, (No. 7,) which guards the access to the rear of the town from a landing in that quarter. The road leading thence is further protected, where it borders a small lake, by two inland Batteries, Nos. 5 and 6, about a quarter of a mile S. E. of No. 7.

Though the Battery in the pass, (No. 3,) and No. 7, are only some 1200 yards apart, yet the contour of the ground between them prevents their efficient co-operation, and restricts each to its special purpose. No. 3 is, however, commanded by the broadsides of the ships, which can sweep the pass when sprung in that direction, and the steep slopes on its flanks also afford excellent positions for musketry.

The entrance to the port is interdicted by the joint fire of three Batteries, No. 1 on Signal Cape,—No. 2 on the spit that divides the port, placed just where it issues from the main shore, —and by No. 4, entirely outside the port, on the borders of the bay, about 900 yards south of No. 2. Each of these bear upon any part of the outer port, and sweep well the approaches to it: with them concurred the broadsides of the *Aurora*, 44, and *Dwina*, 18, anchored in the inner port, close to the passage from the outer port, so narrow as not to exceed a hundred yards across,—their guns commanding, at most effective range, the outer port, and looking over the spit well into the harbor of Awatska.

The Allied squadron, consisting of the British frigates, *President*, 50, *Pique*, 40, and steamer *Virago*, 6, under Rear Admiral Price; with the French frigates, *Forte*, and *Eurydice*, and the brig *Obligado*, under Rear Admiral des Pointes, left Honolulu on the 25th of August, and were off the entrance to Awatska Bay on the 28th. That afternoon, the *Virago* and brig went in with the Admirals to reconnoitre. Next morning, the ships entered Awatska Bay, and steered up for Petropaulski, anchoring near the entrance to its outer Port. The *Virago* stood in near enough to exchange shots with one of the exterior batteries, probably in order to test its force.

On the 30th, the ships were under way, bearing in to engage, when it became known that the

English Admiral had been fatally wounded by a pistol shot; the attack was therefore postponed.

On the 31st operations were resumed by the squadron, which closed in to attack the batteries of the outer Port. According to the Russian plan of the affair, the ships formed in line about 600 yards S. W. of the Battery (No. 1) on Signal Cape, where the broadsides of the *Aurora* and *Dwina* were masked by the intervening headland, and the fire of the most powerful work (No. 2) also appeared to be in a measure obstructed by the same obstacle. The *Pique* directed her guns upon the Cape Battery, while the *President* and *Forte* gave their attention to the outermost work (No. 4), and having soon silenced it, a party of seamen and marines was landed from the *Virago*, which, notwithstanding a distant fire from the *Aurora* and consort, succeeded in gaining the work, when they spiked the guns and broke up the carriages before a Russian detachment could come up to prevent it. The re-embarkation was then effected without loss. This done, the *President* and *Forte* joined their fire to that of the *Pique*, but it was soon found that the guns of the Spit Battery (No. 2) were particularly annoying to the *Forte*, which was hulled repeatedly by its shot. Wherefore, the two ships turned their broadsides that way, and after a well-maintained cannonade, succeeded in disabling many of the guns; upon which the Russians evacuated the work, and moved towards their ships.

Though the fire of the batteries defending the outer port appeared to be now quelled, yet the day was well advanced, and the most difficult part of the operation remained to be achieved. The pass to the inner port was less than a hundred yards wide, and was raked by the broadsides of the two ships at a very short distance,—while it was by no means certain that the Batteries which had been silenced, were so far disabled as to be incapable of renewing their fire at the most critical moment of the affair.

The determined character of the resistance also indicated that no possible means would be neglected to make good the defence.

Whether these or other motives predominated, it is certain that the Allied Commanders discontinued the attack in this quarter, and some days elapsed, probably in deliberation as to the most advantageous mode of renewing the operation. Finally, it appears to have been determined to silence the batteries (Nos. 1 and 2) outside on the Awatska shore, and to land a body of men to the northward and westward of the town, who were to descend to the rear of it, and take it as well as the principal battery defending it, in reverse. Accordingly on the 4th of September, early in the morning, the *Virago* received the landing party, 700 strong of English and French, equally divided, and taking in tow the *President* and *Forte*, steamed in towards the batteries. The *President* cast off about 600 yards from battery

No. 2, placed in the gorge of the high land on the Peninsula, and a warm fire was opened on both sides. The batteries aimed well, and the frigate received considerable damage, but in no great time cleared the work. The *Forte* had less difficulty with No. 1, and this being silenced, the *Virago* disembarked the men without delay. The course selected, led the party up a steep ascent, where they encountered a thick and tangled undergrowth, and found themselves exposed to a severe fire of musketry from an ambush which told with fatal effect. After gallantly sustaining an unavailing struggle and severe loss, a retreat became necessary, which was attended with much confusion. The party then re-embarked, and reached their ships before noon.

On the 6th, the squadron weighed anchor and put to sea.

It appears from the official returns, that the English loss in killed, wounded and missing was 107. The French 102, making a total of 209.

The Russian loss is said to have been of like amount, but this is not stated in their own accounts.

Harbor
of
SEVASTOPOL
From Admiralty Chart
1855.
Wasp Fort 8 G.
Cape Constantine
Fort Constantine
104 G.
Battery 111 G.
Battery 108 G.
SEVASTOPOL HARBOR
Fort Alexander
61 G.
Fort Nicholas
92 G.
Quarantine Battery
Quarantine Bay
Star Battery
Artillery Bay
Gate
SEVASTOPOL
Cemetery
Gate
Gate
Catherine Battery

NAVAL CANNONADE OF SEVASTOPOL.*

17th of October, 1854.

The French and English works around the south side of Sevastopol being sufficiently advanced, on the 16th of October orders were issued by the Generals for a general opening of the siege batteries, next morning at 6½ o'clock, upon a signal of three bombs in succession from the centre of the French lines; and, in order to relieve the left of the latter from the full play of the Russian guns, particularly those of the Quarantine Battery which enfiladed them with effect, the Admirals had agreed to bring in the ships and cannonade the southern portion of the town, the port and forts at the Quarantine, Alexander and Artillery Bay.

As the fire of Fort Constantine would have more or less effect on the fleet while engaged, it was indispensable to include it in the general operation, and also the works on the cape and bluffs to the rear of it, which, in turn, would command the attack on Fort Constantine.

It will thus be perceived how well connected was the whole system of Russian defence in

* From official English, French, and Russian Reports, letters of public correspondents, &c.

this direction—each work supported by another, so that no one could be singled out as the object of a separate attack.

The official Reports of the French, English, and Russian commanders, furnish a brief account of the leading incidents of the naval operations on that day; sufficient, perhaps, for all general purposes, considering that the design of cannonading by sea was merely to effect a diversion for the land attack; but it is altogether wanting in those technical minutiæ that the professional inquirer needs to elucidate some of the vexed questions that embarrass the business of the seaman, as well as the speculations of the student.

In the absence of authentic data, some assistance is to be had in the graphic and interesting correspondence of the Press; with which means, and a due share of reasonable inference, we make out the following view of the case:—

The allied force engaged, consisted of 14 French, 10 British and 2 Turkish ships-of-the-line, some of which had auxiliary steam, but most of them were without; there was a number of side-wheel steamers, of large and small class, to tow these.

British Division.

	Guns.				Guns.
1. Agamemnon,.....	90	*screw.*			
2. Sanspareil,.....	81	*screw.*			
3. Albion,.....	90	.....	Towed by	Firebrand,..	6
4. Queen,.....	116	.....	"	Vesuvius,..	6
5. Britannia,.....	120	.....	"	Furious,....	16
6. Trafalgar,.....	120	.....	"	Retribution,	28
7. London,.....	90	.....	"	Niger,.....	14
8. Vengeance,.....	84	.....	"	Highflyer,..	21
9. Rodney,.....	90	.....	"	Spiteful,....	6
10. Bellerophon,.....	78	.....	"	Cyclops,....	6
Arethusa,.....	50	.....	"	Triton,....	3
Samson,.....	6	*side-wheel.*			—
Terrible,.....	21	"			106
	1036				
	106				
	1142				

French Division.

	Guns.	Horse Power.			Guns.
1. Napoleon,.....	92	*screw*, 960			
2. Henry IV,.....	100				
3. Valmy,.....	120	.....	Towed by the	Descartes,..	20
4. Paris,.....	120	.....	"	Primauget,.	8
5. Jupiter,.....	90	.....	"	C. Colombo,	
6. Friedland,.....	120	.....	"	Vauban,....	20
7. Marengo,.....	80	.....	"	Labrador,..	
8. Montebello,....	120	*screw*, 160			
9. Suffren,.....	90	.....	"	Albatross,..	
10. Jean Bart,.....	90	*screw*, 450			
11. Charlemagne,..	90	*screw*, 450			
12. Bayard,.....	90	.....	"	Orenoque,..	
13. Alger,.....	80	.....	"	Magellan,...	14
14. Marseilles,.....	80				
	1362				

The measures taken on the part of the Russians to close the entrance, by sinking some of their heavy ships, had the additional effect of limiting the positions of the ships of the Allied squadrons, though they only contemplated an attack on the outer forts; and the reefs that lined the shores on both sides, restricted still further the opportunity of close approach to large vessels, except under disadvantages that left little chance of success. All this will be perceived from the manner in which the operation was conducted, and the events of the day.

The weather was fine, rather warm and calm, except when a faint air occasionally swept by —wherefore no sail was loosed throughout the fleet, and steam was relied on for placing the ships. Early in the morning, preparatory signals for battle were displayed. Steamers were lashed on the port side of the line-of-battle-ships that were without screws, and about 10½ o'clock the divisions were moving in for their stations.

The attack is divisible into two distinct parts, that by the general line, the other by the detached squadron. The general line was formed by all the French and a majority of the English ships,—they steered for the entrance of the harbor, keeping the southern shore aboard, close in with which, at the entrance of the Chersonese inlet, the *Charlemagne* anchored. The other ships following

the *Charlemagne*, on approaching her, kept away to the northward for their positions, which, it seems, were not always attained exactly, and therefore the line was not formed with precision; but no ill consequence seems to have arisen from this circumstance; none certainly that would have affected the result.

The *Charlemagne* was about 1500 yards from the nearest Russian work, the Quarantine Battery, and this distance was increased by each vessel successively; so that the French Admiral, whose ship was the most northwardly in the line of his division, was probably about 2000 yards from the Quarantine Battery.

Further to the northward lay the British Admiral's ship, (*Britannia*,) which was nearly the same distance (about 2000 yards) from the Quarantine Battery to the south and Fort Constantine to the north.

Next to the Admiral's ship, was the *Trafalgar*,—then in order the *Vengeance*, *Bellerophon* and *Queen*.

The line formed by the English division, in stretching northwardly, lay off Fort Constantine, as intended, and inclined shorewardly towards that work. So that the northernmost ship of the general line (*Queen*) was about 1200 yards from the fort, and rather less from the Telegraph Battery, behind it on the bluff.

The two Turkish ships managed, in getting to their stations, to embarrass some of the Eng-

lish ships, and would probably have done most good if they had kept out of action altogether.

The first French ship, (*Charlemagne*,) was opened on by the Russians at long range, receiving several shot and shells before she anchored and began to return the fire, which was about one o'clock; at which time the batteries of their comrades ashore had been silenced: her smoke-stack and masts were distinctly seen from the high ground about the lines, as she bore down to her station; several ships followed in support, and for a while, sustained the brunt of the fire, as some delay occurred before the whole line was in position and engaged.

The French ships,—supposing that their cannon were entirely confined to the southern works,—opposed upwards of 600 pieces to the guns in that quarter, estimated to be about 350 in number.

The guns of the northern works, estimated at 130 pieces, were opposed by the broadsides of the English ships of the general line, showing about 300 guns in broadside.

No authentic information is yet public in regard to the calibres of the Russian guns seaward; but the calibres of the English and French ordnance were of course 32 and 30-pdr., with a moderate number of the Canon Obusier of 22 ^{cnt}, and a much larger proportion of the 8-inch shell-guns.

The English ships had a considerable number of their men ashore, serving in the Siege Batteries, which probably diminished their loss without impairing the efficacy of their fire, or the management of the ships, as the spar-deck guns only were unserved, and no sails were loosed, the movements being executed under steam.

The detached squadron pursued an entirely different course from the ships of the general line. The latter, as already stated, got into position by steering along the southern shore, until at the desired distance from the Quarantine works, when they kept away northwardly in succession. Rear Admiral Lyons, on the contrary, ran in for the shore to the rear of Fort Constantine, and edged close along it, anchoring as near to the works as the depth of water allowed.

The vessels under his command were the only English screw-ships, *Agamemnon*, 90, and *Sanspareil*, 81,—*Albion*, 90,—*London*, 90,—and frigate *Arethusa*, towed by the steamers—also the side-wheel steamers *Terrible* and *Samson*;—showing a total force of 200 guns in broadside, having a considerable number of 8-inch shell-guns, and some heavy 56-pdrs. and 68-pdrs.

The *Terrible*, a powerful vessel of that class, preceded her companions, and about 1h. 30min., P. M., commenced a skirmishing fire with the

long 68-pdrs. at the works upon the bluffs. The Rear Admiral led his line, and deliberately steaming along the shore as close as possible, took post in a bight of the shoal, right off the retired sea face of Fort Constantine, and as near to it as allowed by the depth of water, (¼ less 5 fathoms, or 27½ feet.) The station was remarkably well chosen, probably the best that circumstances permitted. Further south, the water shoaled, and the position, moreover, might have proved to be more exposed to the guns on both sides of the entrance,—further north, the fire from the works on the bluffs became more intense,—further in, the ship would probably have grounded, and further off would have impaired the very purpose of the detached squadron.

The distance of the *Agamemnon* has been variously estimated from 600 to 900 yards,—it may be assumed as 750 to 800 yards.

The *Sanspareil*, following the *Agamemnon*, anchored astern of her; then in order the *London*, *Arethusa*, and *Albion*,—each successively augmenting the distance from Fort Constantine, and getting nearer to the works on the bluffs, to the northward of the fort; the *London* being abreast of the Telegraph Battery, the *Albion* abeam of the "Wasp Tower," and the distance of the line generally about 500 yards from the guns of these batteries. It was

2, P. M., before the *Agamemnon* fairly opened. The *Albion* about 20 minutes later.

The action which ensued between the general line and the forts, was little more than a plain cannonading for some five hours, with scarcely an event of unusual interest. The fire of the ships was rapid and continuous, but 32 and 30-pdrs, with 8-inch and 22$^{cwt.}$ shell-guns, must have lacked the force and concentration to damage regular works at distances of 1500 to 2000 yards; though, about 2$^{h.}$ 30$^{min.}$, the Russians are said to have slackened fire, and the Quarantine Battery was silent; but this may not have been due to any serious loss, as they soon resumed. It is also known from the Russian Report, that these works suffered but little.

On the other hand, the ships which formed the principal line, appeared to have sustained no material damage, in hulls or rigging, though some of them lost a number of men.

The detached squadron received and inflicted greater damage, as would naturally be inferred from its position.

The fire was vigorously maintained by both sides, the *Agamemnon* and *Sanspareil* battering the sea fronts of Constantine, which was returned with steadiness, but with no vital harm to the two ships. It was soon perceived, however, that the *Sanspareil* was suffering from the guns of the works on the bluffs, which plunged

down shot and shells, in some degree raking the position, notwithstanding that the *London*, *Albion*, *Arethusa* and two steamers were doing their best to quell this galling fire. So effectually was it maintained, that in an hour (3h 20min) the *Albion* was towed out, badly cut up in hull, men and spars, and on fire in two places from hot shot or shells.

The *Arethusa* and *London* soon experienced similar treatment, and were towed out in but little better plight.

This left the works on the bluffs free to give entire attention to the *Agamemnon* and *Sans-pareil*, which were indeed already sufficiently occupied with Fort Constantine.

Admiral Lyons fully perceived the danger of his situation, but neither he nor his second, the Commander of the *Sanspareil*, seem to have contemplated the relinquishment of the post. A request for assistance was sent to the *Bellerophon* which lay in the general line just outside of the *Agamemnon*, some 400 or 500 yards further off. The *Queen* very opportunely approached about the same time, having left her assigned position because incommoded by the Turkish ships. Sheering in towards the remnant of the detached squadron, so gallantly meeting the odds, the two new-comers took the stations just vacated by the damaged vessels.

The *Queen* was not long engaged before she took fire from a hot shot, and it was necessary

to tow her out of action. The *Bellerophon* was more lucky, and kept her new position in aid of the *Agamemnon* and *Sanspareil*. But the *Rodney*, which had also stood in from the general line to relieve her comrades, in attempting to approach or pass the *Agamemnon** from the southward, realized very unpleasantly how little room the Admiral had left to improve on his choice of position.

The ship grounded not far from the *Agamemnon* in a more exposed situation to the fire of the Fort, suffering much damage therefrom; and although speedily assisted by some of the towing steamers, was not afloat until the action was nearly concluded. For the day was now drawing to a close, and the mists of the evening were beginning to mingle with the dense smoke that enveloped the battle.

When quite dark, the ships of the fleet slipped or weighed, and hauled out of gun-shot.

The siege batteries opened vigorously in general concert, at 6½ o'clock on the morning of the 17th of October, upon sight of the appointed signal, and at the same time, or very soon after, the ships should have engaged the Quarantine

* So closely, it is stated by one writer, that the *Agamemnon* veered and backed astern to avoid being fouled.

Battery on the south side, in order to relieve the French left from its severe enfilading fire;—for the French General must soon have been made conscious of the fact that his batteries were overmatched by the Russian fire, and must eventually be silenced, unless the expected diversion were effected in season by the fleet.

It was evident that his observation was turned that way, for his experienced eye soon detected that the ships were not even in motion, and his journal records the brief but significant sentence, "*Les flottes n'ont pas encore pu appareiller.*" About $10^{h.}$ $30^{min.}$ A. M. after the blowing up of several magazines, and the dismounting of a number of guns, the French batteries were silenced, and then ceased all motive for prosecuting the cannonade by sea. No sufficient reason is given for the delay of the fleet, which virtually defeated the sole and important object of the whole Naval operation. The towing of so many large ships, was no doubt a slow proceeding; but that must surely have been well known before hand, and could have been provided for by starting in season. The diversion might not, probably would not, have effected the result; but a simultaneous execution certainly held out the only prospect of success.

Apart from this, the cannonading by the general line was quite as effective as could be expected. The distance varied from 1500 to 2000 yards,—the calibres were 32-pdrs., with a

proportion of shell-guns, and their objects of fire, regular fortifications of heavy masonry.

Under these circumstances, the casemated portions of the Russian works were hardly to be disturbed, even by the most incessant fire; though the uncovered men and guns might be damaged seriously, and their operations suspended, for a while, which is stated by the Allies to have been the case, particularly with the Quarantine Battery, where the cannon were *en barbette*, and being the most advanced, were therefore the most exposed. But the fire was subsequently resumed, and the Russian Commander avers, that all of the works on the south side suffered but little.

The ships in the general line appear to have been quite as little damaged in their hulls by the Russian fire from this quarter;—but some of them had a number of men disabled, while others, seemingly as much exposed, did not lose a man.

The *Agamemnon* was very seriously maltreated, though not to such an extent as to impair her power of battery or engine. She was on fire several times; was struck by 240 shot or shells; and, singular to say, only lost 29 men, while her second, just by, lost 70 men. The *Albion* suffered still more, and in an hour was towed out, crippled and on fire in more than one place, with a loss of 81 men. The crews of the *London* and *Arethusa* fared

rather better, but the ships nearly as ill, and they too remained in station but a little time after the *Albion*. The *Queen* was driven off soon after she got into her new position, in great danger; and the *Rodney* had the bare satisfaction of getting aground and afloat after experiencing some damage.

The value of the small works on the cape and bluffs, was clearly defined in these results; being above the dense cloud of smoke that enveloped the ships and the lower forts, their aim was not embarrassed, while the seamen labored under the difficulty of firing with an inconvenient elevation, at objects that they saw but seldom, and then but dimly and briefly. As a consequence, three line-of-battle-ships and a frigate were driven off very shortly and in great peril, and a fourth badly cut up; while the *Agamemnon* lay opposed to one of the heaviest sea-forts with two tiers of casemates, and at the end of five hours came off with comparatively little loss.

The fire of both ships and forts would have been more fatal, had it not been for the extraordinary accumulation of smoke, which is noticed in every account of the action,—particularly as no ship was within point blank range, and more or less elevation of the guns was, therefore, required; the damage to some of the ships of the detached squadron must also have been much greater, had it not been

for the timely interposition of the steamers which removed from action the *Albion*, *Queen*, *London*, *Arethusa* and *Rodney*, when in such danger that no other means seemed able to avert the extreme peril that threatened them.

The frequency of conflagration in the vessels, due to hot shot or shells, is well worthy of note.

The *Agamemnon* is said to have fired 2700 shot and shells, which is an average of 60 per gun of the broadside.

The killed and wounded in the Allied fleet are thus stated:—

English.		French.	
Agamemnon,	29	Henri IV.,	15
Sanspareil,	70	Valmy,	30
Albion,	81	Paris,	46
Queen,	8	Jupiter,	0
Britannia,	9	Friedland,	42
Trafalgar,	2	Marengo,	0
London,	22	Montebello,	32
Vengeance,	2	Suffren,	4
Rodney,	2	Jean Bart,	2
Bellerophon,	19	Charlemagne,	37
Arethusa,	18	Bayard,	0
Samson,	3	Alger,	0
Terrible,	9	Marseilles,	0
Nine steamers,	36	Seven steamers,	7
	310		215

This damage to the personal of the fleet was considerable, as will appear if compared

with the number of men killed and wounded, in previous naval actions.

		No. of Ships in Line.	Crew disabled.	Greatest No. in one Ship.	Average per Ship.
At Sea,	1st June, 1794,	26	922	158	35
	St. Vincent,	15	301	81	20
	Camperdown,	16	825	148	52
	Nile,	13	882	197	68
	Copenhagen,	9	682	220	76
	Trafalgar,	27	1690	200	63
	Algiers,	6	638	210	106
	Navarino,	3	195	76	65
	Acre,	7	22	11	3
Sevastopol.	Detached Squadron,	4	202	81	51
	Entire Fleet,	23	525	81	23

The naval attack of the 17th owes whatever interest it may possess to the spirited and brilliant episode enacted by the detached squadron which, going beyond all prudential considerations, must have exercised a wholesome influence on the public mind, as well as upon the officers and seamen of the fleet, although it may not have advanced the operations of the siege. Still, its Nelsonian vigor contrasted pleasantly with the irksome monotony that circumstances seemed to have imposed on the routine of naval operations in the Black Sea and Baltic, affording an earnest of the disposition and the capabilities of the fleet. It was boldly conceived, gallantly executed, and really effected more than seemed possible against a regular work of such strength.

THE VLADIMIR.

(Extract from the Log of the Russian Steamer *Vladimir*, in the Harbor of Sevastopol, 1854–55.)

This vessel performed a conspicous part during the Siege of Sevastopol, and rendered valuable aid on many occasions, particularly on the 18th June, in assisting with other steamers to check the fierce assault of the French columns upon the Malakoff and works adjacent to the Kilenbalka Bay—for which a handsome acknowledgment was returned in the Official Reports of the commanding Generals.

Other acts of gallantry and good conduct, such as the sudden issue of the steamer from the harbor on the 6th December, in order to shell some out-lying French works, indicate enterprise and professional skill on the part of her commander, Captain Boutakoff.

The following citations from his Journal will, therefore, be read with interest.

It may be premised that the *Vladimir* was a side-wheel steamer, built in England in 1848, and, therefore, in all probability the ordnance here spoken of was of English calibre, &c.

1854, *October* 17*th*.

At 7 in the morning the hostile batteries opened a furious fire, which was extended all

around the town. The battery situated on the heights of Kilenbalka, at a distance of 23 cables from the roads, mounted five cannon, of which four were directed against the Malakoff, and one upon the roads. The steamers *Vladimir* and *Crimea*, with the Line-of-battle-ship *Gabriel*, replied to it.* In order to reach the work with the 10-inch guns, the *Vladimir* was heeled to 7°, —the port side of the vessel being depressed: for which purpose the starboard paddle-box boat was lowered, and that on the port side left suspended at the davits,—the men also were kept on the port side that were not required at the guns. In this position, the 10-inch guns were at an angle of 22° with the horizon, the tangent sights being at 17½°, and their shells reached the battery. The tangent sight of the 68-pdr. was at 15½° and 15½°—the fuses, 17 seconds.

At 11 o'clock, a 68-pdr. shot entered the side of the vessel near the upper cabin, and after striking successively several objects, fell on the cabin deck.

At 11½ o'clock, a shot entered in the starboard side below the water-line; it was plugged, but without stopping the leakage, for the shot could not be got out; its progress to the hold had been arrested by part of the interior iron bracing.

* The calibres used by the *Vladimir* were 68-pdrs. and 10-inch. The *Crimea* had 10-inch. The *Gabriel* 36-pdrs., from which shot only were fired.

At half an hour past noon, the enemy's fleet came in from seaward towards the batteries at the entrance of the harbor, and began a violent cannonade, which was returned from our side in like manner.

At 6 in the evening, the firing ceased on both sides. During the day, the *Vladimir* fired 186 shells and 72 shot.

Throughout the whole night the pumps were kept going.

October 18th.

At 6 in the morning, the cannonade was resumed around the city. At 9 the leakage of the vessel was stopped by the divers, who worked under the fire of the enemy. Towards noon the enemy's battery that was opposed to the Malakoff and the roads, began to slacken its fire. The mean interval between the shot directed towards the latter, was 6 minutes; so that the guns fired about 100 rounds per day.

At half an hour after noon, another 68-pdr. was mounted in the battery looking down upon the roads, and a fire of shells, with shot, hot and cold, was maintained from the two guns. The hot shot seldom reached us, but falling near the shore in the shallow water, threw up jets of vapor.

At 2, P. M., a shot struck the vessel on the starboard side, below the water-line. The hole was stopped during the night by the divers, who

worked with the light of lanterns. This day the *Vladimir* threw 67 shells and 79 shot.

October 19th.

At 9 in the morning, as soon as the fog had passed off, we opened fire on the enemy's battery.

At 11, A. M., a shot went through abaft the port wheel, and continued its flight onwards.

At 11¼, a shot cut in two a spare studding-sail boom near the foremast, and fell overboard. Several shells burst quite near the ship without doing any damage, chiefly because the fragments preserved their onward movement. Some shells did not reach, but fell into the water some ten yards off, and a tremor was perceptible in the submerged part of the vessel. According to the divers, slight dints were noticeable on the copper sheathing.*

Just after noon, a shot struck the main-top.

At 3, P. M., a shot entered the starboard bow, below the water-line, and remained in the wood. At 4.30, P. M., another shot went through the starboard bow. The water began to come in

* Subsequently, (7th June, 1855,) when we were under fire the whole night, we had an opportunity of being satisfied, that when shells fell into the water, they still burst after a considerable lapse of time, and in each instance communicated a shock or tremor to the ship under water, even if they fell half a cable from us, which could not have been occasioned by the impact of a fragment.—for at that distance it seemed certain that none could have reached us.

there, but the divers stopped it in course of the night. Threw 58 shells.

20th of October.

At 7, A. M., the enemy's battery only replied to us with a single cannon. We were informed by deserters that one gun had burst, and the others were conveyed to another battery,—that the piece directed upon the roadstead was a Lancaster, from which round projectiles were fired for the want of conical.*

At 11.30, A. M., a shot entered the ship, killing one man, and wounding two others.

At 5 P. M., a shot passed through both sides of the vessel; we fired 30 shells and 13 shot during the day.

21st of October.

Got up steam and steered towards the barracks of the 42d *equipage*.

At 11 A. M., fired five rounds by way of trial, at the English Battery of 22 guns, which was directing its fire on the Malakoff and the 3d Bastion: as we could not see it from the steamer (*Vladimir*), the falling of our shot was observed from the Hill, and the direction of the gun corrected thereby.

At 5¾ P. M, the *Vladimir* was anchored

* This was subsequently confirmed by the English journals.

abreast of Kilenbalka, by way of precaution, in case of a night attack on the city.

22d of October.

At 6 o'clock A. M., the vessel was steered for the Powder Magazine of Gieorgieffsk, and anchored near it, in order to operate against the English Battery. Rear Admiral Istomine sent word that our shells annoyed the enemy much. At 6 o'clock in the evening, we returned to Kilenbalka.

The sketch No. 1, is intended to explain the means used to direct the guns against the high ground. In approximating the distance by the chart, it was evident from the tables for range, (calculated for horizontal distance) that the desired spot could not possibily be reached by any gun on board the *Vladimir*—neither of 8-in. or 10-in., nor the 68-pdrs. Attempts were made with the last named, as it offered the best chances of annoying the enemy. The trial shots proved it to be impossible to reach that far, so long as the vessel was on an even keel. She was then heeled over, until the shot began to tell: and in this way was ascertained the number of degrees on the tangent sight, when its notch was aligned with the swell of the muzzle and enemy's Battery,—which proved to be 15¼°,—with which, the shells and hollow-shot fell rightly.

After being assured by observing the mean of

several shot, that the proper elevation was had for the 68-pdr., orders were given to continue the fire without changing the elevation. At the same time the heel of the vessel was increased for the 10-in. guns. It will be understood that in making trial of the 68-pdr., the entire elevation had been given that the carriage admitted of; for which purpose the coin and bed had been withdrawn. Subsequently when the inclination of the vessel was increased, the gunners were obliged to replace the coin in order to preserve the gun at its proper elevation.

For the 10-in. guns, it was necessary to heel the steamer 7°, so as to give the axis of bore an elevation of 22° with the horizon, (by the quadrant,) the angle on the tangent sight being then 17⅓°. The fuzes were of 17 seconds.

In this way the gunners were enabled by means of the sight, to observe any change in the position of the vessel, produced by the wind or other causes, and thereby to adjust the heel of the vessel.

The great elevation given to our guns, seems to have induced the English papers to suppose that our steamers were armed with mortars upon the plan of Roberts.

In the work on Artillery, by Douglas, (page 263), it is stated, that the deviation of *hollow* projectiles from the line of fire, is double that of solid shot; but nothing is said of the deviation at a distance of 4½ versts, (3 miles.) *Our vessels*

generally threw shells, since it was evident shot were nearly harmless so far: sometimes three shells would strike the embrasures in succession, but a shell from the same gun would, soon afterwards, fall considerably to the right or left, without any apparent cause. The condition of the atmosphere was the same, the gunner had not been changed, nor his good will to reach the enemy. After many rounds the gun was lowered ¼°, inasmuch as the charge was found to ignite with more violence as the bore became heated.

A young Englishman who had been made prisoner (5th November) near the English Battery, reports that a sentry was posted whose business it was to cry out, "Steamer," whenever we fired, in order that the men might shelter themselves from the splinters of the shell. He also stated, that their Lancaster cannon was only loaded with spherical projectiles, the conical having been transferred to another battery where they were needed; and in fact all the shot that reached us were round; they were probably adjusted to the oval bore of the Lancaster, by a wooden filling. As to the accuracy of fire at great distances, of the Lancaster cannon as well as our own, (with spherical projectiles,) it may be affirmed there was no difference, although the English, being located on elevated ground 600 feet in height, were not obliged to elevate their guns as much as ourselves. Often, after

two of their shot had ranged well, dozens of projectiles would go over the vessel, or fall considerably to the right or left of it. They made use of one kind especially, the peculiar sound of which would apprise us before hand when it would be likely to fall on the shore without reaching us. Upon which the officer on duty would direct the men to run about the deck, to make the English believe that they had struck the vessel; which seemed to encourage them more than once to continue firing these projectiles, though they never did reach us. We could not succeed in ascertaining what kind these were. Their hot shot probably had considerable windage, for they also failed to reach, and falling into shallow water, threw up jets of vapor.

The following extract of a letter from Admiral Istomine to the Commander of the *Vladimir*, (February 9th,) may afford some evidence of the efficacy of very distant firing:—"I must again "ask for the co-operation of your guns. The "French have commenced a Redoubt not far "from the English 5 gun Battery, &c., &c., &c. "Try the long range of your heavy shells on "this work."

As to the value of 68-pdrs. at less distances, I will quote the following facts:—In 1854, while stationary and about 25 cables length from the English battery, which we call *Cyclops*, of some 500 shot fired from it at the steamer, (delibe-

rately, the intervals being six minutes,) only 10 struck, (not counting some which cut the rigging;) that is, 2 per cent. hit the hull: while on the 8th of June, 1855, being nearly 18 cables length from the French batteries, six shot out of 60 struck the vessel, (not including 7 which cut the rigging;) that is 10 per cent. hit the hull.

The amount of penetration was nearly alike in both cases; though there was a marked difference in this respect, between the *Vladimir* and the *Gabriel*, which was also at the same distance, the latter being pierced through and through below the water-line. It is true, this vessel was built at Nicolaief in 1839, while the *Vladimir* was built in England in 1848.

The necessity of inclining the steamer in order to give sufficient elevation to the guns, occasioned great inconvenience. But there was then no chance left us for a meeting on the open sea, as the entrance to the harbor was blocked, and besides, the enemy kept several large steamers in readiness to act, (ever since the sally of the "*Vladimir*" and "*Chersonese*" on the 6th of December;*) wherefore, there was no

* "Two Russian Steamers performed a very daring exploit on "the 6th of December. One was a Steam Frigate, and the "other the *Vladimir*, which is constantly on the move in the "roadstead, and had often annoyed us with a gun of long range. "At half past one on that day, the Russian frigate suddenly "moved from its position not far from the entrance to Careening "(Kilenbalka) Bay, and proceeded under full steam towards the

longer need of carriages of little height, on which the centre of gravity of the gun is kept as near as possible to the deck. One of the *Vladimir's* officers (Mr. Konstantinoff) has contrived an easy method of giving great elevations to guns without heeling the ship; and this was adopted forthwith, inasmuch as, in case of putting to sea, the guns could be restored to their original situation. This was effected by wedge-like pieces of wood, placed under the carriage, as shown in figure 1. The inner straps, which include the fore-trucks, were replaced by others of greater length, and in this way the cannon might be elevated 24°, without heeling the vessel.

This contrivance of Mr. Konstantinoff very soon proved exceedingly useful. During the assault of the 18th of June, the *Vladimir*, keep-

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"entrance of the Roadstead. As she passed along, a rapid dis-
"charge of shells was made against the new English Batteries
"on the right, especially a square redoubt, placed so as to com-
"mand some of the Russian ships on the south side of the inlet,
"the guns of which, however, were not yet mounted. The move-
"ment of the Russian frigate became an object of general atten-
"tion to all the troops on the heights, from which a view of the
"Roadstead could be obtained. To the surprise of all she went
"past Fort Nicholas and Cape Alexander, and pursued her
"course boldly out to sea, attended by the *Vladimir*. The
"object was soon explained. Rounding the Quarantine Fort and
"harbor, she stood off beyond that part of the coast where are
"said to be the ruins of ancient Chersonesus, and there com-
"menced to throw shot and shell towards the French works,
"which were thus enfiladed by her guns," &c., &c.

Correspondence of "London News."

ing underway, fired with shells along the Kilenbalka; and the power of giving to all the guns a great elevation, enabled us to reach the most remote reserves of the enemy. Nor was this all; at 1200 yards from the shore, attempts were made to scour the ground, to the east of Kilenbalka, with grape, by giving the guns an elevation of 23°. Not a ball fell in the water,—on the contrary, the whole charge was scattered among the heights.

This result determined me to get closer to the entrance of Kilenbalka Bay, and to open with grape upon the sharp-shooters that lay under cover along the slopes of the high ground, opposite to the 2d bastion, and afterwards along the whole extent of the Kilenbalka, where the enemy had retired. The consequences of this fire will be duly appreciated when it is remembered that as many as 155 iron balls (each weighing nearly a pound,) or 800 musket balls are enclosed in a case of 10-inch grape.

By continually changing position, the enemy's battery was prevented from striking the *Vladimir* with shot and shells from their cannon and mortars, though several fragments of shells reached the vessel, and the jets of water from the falling shot wet those who stood on the light deck between the wheel-boxes. Thus this memorable morning, on which the enemy expected to reap the reward of nine months' toil, caused little damage to the *Vladimir*, con-

sidering the violent fire directed upon the vessel One sailor received a contusion on the shoulder; another was wounded in the cheek by the splinter of a shell, and it was only after the heaviest of the firing, when the *Vladimir* was pursued by shells wherever she went or anchored, that a seaman was mortally wounded by a piece of a shell, and another lost a foot.

As to the trajectory of 68-pdr. shot, fired at distances of about 25 cables' length, from a height of 500 or 600 feet, it is well to observe that it forms an angle of 25° to 30° with the water. For distances of 18 cables' length, this angle is 22°. These have been ascertained from the sides of the *Vladimir*, excluding those cases where the shot, after piercing the vessel, has been deflected from its direction by some obstacle, such as knees, &c.

GREGORY BOUTAKOFF,
Captain in the Russian Navy,
Commanding the Vladimir.

BOMBARDMENT OF SVEABORG,*

By the Allied Fleet, August 9th and 10th, 1855.

The harbor of Helsingfors is formed to the east, by the islands of Degero and Sandham,—to the west, by the peninsula where stands the city of Helsingfors, and is completed to the southward by a chain of small islands, which stretch across the opening left in that direction. Midway among these, are the islands of East, West and Lilla-Svarto, Vargon and Gustafsvard, upon which stand the works constituting the redoubtable Fortress of Sveaborg. Rüntan and Langorn lie between these and Helsingfors,—Bakholmen and Kungsholmen to the eastward towards Sandham. All these islands are carefully and powerfully fortified, the batteries appearing from seaward as if perched one on the other, and the channels leading to the passes of the harbor between them have good depths of water, but are beset to some distance by rocky islets, reefs and hidden rocks, which, render skill and caution requisite in approaching.

The object of the operation is distinctly stated in the Report of the English Admiral to have been "limited to such destruction of

* From official accounts by English, French and Russian commanders.

"fortress and arsenal as could be accomplished "by means of mortars;" and it "formed no "part of the plan to attempt a general attack "by the ships on the defences," because of the additions made to the defences of the place, particularly by sea, where batteries had been erected "on every advantageous position com- "manding every practicable approach to the "harbor of this intricate navigation."

The Allied fleet arrived off Helsingfors on the 7th of August, and on the night of that day, the French landed on a small rocky islet, about 2200 yards to the southward and westward of the fortress, where they commenced the erection of a battery for four mortars of 27^{cent}, (10$\frac{2}{3}$ inches.)

The mortar vessels which were to perform the chief part in the attack, took position about two or two and a quarter miles from Sveaborg, obliquely to the general line of its batteries: they were anchored head and stern, with sufficient scope to admit of their position being changed as much as two cables' length, whenever it was found that the Russian ranges were adjusted to the distance.

Some differences are noticed in the accounts which mention the number of mortar vessels. The Report of the British Admiral is silent on the subject. That of the French Admiral states it to be 16 English vessels, each carrying one mortar, and 5 French bomb-ketches, each carry-

ing two mortars. The Russian Report says, 4 vessels of peculiar construction and 16 mortar-boats. A correspondent of the press says there were 16 English mortar-vessels.*

The gun-boats, which were to relieve the mortar-vessels of some of the fire from the batteries, had previously received additional guns of heavy calibre from the ships of the line; they were distributed in divisions, and assigned to different stations somewhat in advance of the line of mortar-vessels. Two of them, armed with Lancaster 68-pdrs., (*Stork* and *Snapper*,) were directed upon a three-decker (*La Russie*) moored so as to command the pass between Gustafsvard and Bakholmen. The gun-boats of each division were to keep continually in motion about a central point; which they did throughout the whole operation, firing upon their opponents as their guns bore. No part of the circles thus described, is supposed to have approached the batteries nearer than 3000 yards.

The number of gun-boats does not appear from the Reports of the Admirals. The Russians say there were 25 of them,—letters of public correspondents state the English gun-boats to have been 16 in number.

The *Cornwallis*, *Hastings* and *Amphion*, 34,

* According to Mr. Mallet, there were 13 mortars. See extract from his notice in the Notes at the end of this volume.

were stationed on the extreme right, to take every opportunity of engaging the Russian batteries on the island of Sandham. The *Arrogant*, 47,—*Cruiser*, 16,—and *Cossack*, 20,—were to observe the troops posted on the island of Drumsio, on the extreme left of the attack, and some small vessels occasionally noticed in that direction. These were the only large ships that came into action,—the rest remained at anchor entirely out of range.

Thus the attack was concentrated directly upon the centre of the line of defence, where stood the fortress and the batteries immediately contiguous, within which were the government arsenals with their docks and extensive dependencies; while small detached squadrons operated at considerable distances to the right and left of the mortar-vessels and gun-boats.

On the morning of the 9th of August, about 8 o'clock, a general fire was begun from the French mortars on the little Longor islet and the mortar-vessels at anchor,—from the gun-boats and detached squadrons manœuvring under steam.

The Russian batteries replied vigorously at first, and the ranges of their heavy guns extended beyond the mortar-vessels, but evidently to so little purpose, by reason of the distance and the continued change of their position, as to be apparent to the Russian commander, who directed that the batteries should only fire upon

the vessels which came within effective range of the artillery.

The *Cornwallis* and her two consorts had stood in towards Sandham, when the action commenced, to attack the south batteries on that island, and the five gun-boats near by. They opened a severe fire at a distance of 2300 yards, and the Battery No. 3, in the centre of the space attacked, received a shower of projectiles, but replied rapidly and accurately, and towards noon the vessels hauled out of range.*

On the Russian right, the *Arrogant*, *Cruiser* and *Cossack*, closed in with the island of Drumsio, and opened on the troops there, at a distance of 1200 yards.

In the meantime, the mortars and heavy pivot-guns poured an incessant storm of shells on Sveaborg and all around it,—firing and destroying every building within range, but with little effect on the defences, or on the powder magazines, which resisted to the last, except some old Swedish magazines on Gustafsvard, which proved too weak to endure the repeated shocks of the heavy bombs. Four lots of charged shells were stored there; about noon one of them was ignited by a bomb,—the others soon caught, and the whole four exploded in rapid succession, exhibiting a most

* The three vessels are stated to have fired some 3000 shot and shells, by volleys, into the works.

imposing appearance. Only four men, however, were disabled by the occurrence.

During the afternoon, the bombardment was continued with increased vigor. About 3, P. M., a Russian account states, the rate of firing was 36 shots per minute; an hour or two earlier, it had been only 15 to 20 per minute. The *Rusie* was suffering considerably,—her decks were penetrated by shells of great calibre, one of which nearly reached her magazine, and the ship was only saved by great exertion.

Before sunset, the gun-boats were recalled, for they had grounded occasionally during the day; and about 9 o'clock in the evening, the boats of the fleet commenced with rockets, at a range of some 2000 yards, thus sustaining and increasing the conflagration ashore. The practice was continued with bombs at intervals, until 2 o'clock on the morning of the 10th, and at daylight the gun-boats were ordered to go in and resume their fire. The positions of the mortar-vessels were also advanced to an easier range.

During the whole of the 10th of August, the bombardment was continued as on the day before, without a minute's intermission, and fresh conflagrations were ensuing continually. All the buildings of the port, with the workshops and magazines, inside the fortifications of Svarto were in flames. About 10 in the morning, the deck of a gun-boat, which served as a depot for shells and ammunition, took fire, to the im-

minent danger of the Citerne battery and the works on Gustafsvard. It was happily extinguished at once by the intrepid exertions of officers and men. The *Russie* had been removed from her exposed situation and was now out of range.

About $2^{h.}$ $40^{min.}$ in the afternoon, some French gun-boats wishing to change position, sent boats to sound westwardly, but they were repulsed by the fire of a Battery in Helsingfors. In the evening, the gun-boats were again recalled, and the boats of the fleets resumed the Rocket practice, but with little effect,—the mortars were also kept in play.

The Russians only replied when an occasion was offered by the approach of a boat within good range.

Next morning, (the 11th,) at day-light, the bombardment ceased, the Admirals considering that they had now inflicted all the damage in their power. But few buildings were undestroyed on Vargon, and those left on Svarto were at the extreme range, and had not been touched by any shells.

The destruction of buildings private and public about Sveaborg, appears to have been very great. But the damage to fortifications, batteries, guns, and large magazines was insignificant: which seems to have been apparent from the fleet, as the report of the English Admiral admits the sea defences, in general, to be but little injured.

The Russians lost 44 men killed and 115 wounded, ashore; in the *Russie* 11 killed and 89 wounded—in the *Ezekiel*, one wounded,—being a total of 260 disabled.

The Allied loss was very trifling. In the English vessels, 33 men were wounded, the most serious of which were from the bursting of their own Rockets. In the skirmish with the Sandham batteries, the *Cornwallis* received 19 shot in the hull, and had 10 men wounded,—the *Hastings*, 2, and the *Amphion* 3.

The expenditure of ammunition in this operation was of course very considerable, but we have only the means of approximating the amount. The Russians estimate that 1000 projectiles were fired at Drumsio,—17000 at Sveaborg and the adjacent works,—3000 at Sandham: in all 21000, of which many are supposed by the Russians to have weighed 250 pounds.* A public correspondent says the English fired from the mortal vessels, 3099 13-inch bombs, and from the gun-boats 11200 shot and shell. The French fired 3000 10-inch bombs, and from the gun-boats, 6000 shot and shells,—making a total of 23299 shot, shells and bombs.

The English mortars are said to have endured the continued firing rather indifferently. On the

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* The English 13-inch shell weighs, with its charge, 207 lbs. The French 27$^{cent.}$ shell is much thinner, and though bulkier, weighs with its charge, only about 115 lbs.

first day, five of them exhibited large cavities in the bores, which were filled with an alloy of zinc and tin, a very temporary expedient that sufficed for 60 or 70 rounds. Next day, five more showed defects of like character, three burst, and the remaining three were seemingly in no condition for much further service.* Unfavorable indications were also said to have been observed in the heavy ordnance of the gun-boats. What these were we are unable to say, but it seems altogether out of the question that good pieces should suffer at all from two days' continued practice. In recent proofs we have seen a piece weighing seven tons, stand 2000 rounds of shells, twice the weight of a 68-pdr. shot, without bursting; another of like description looked nearly perfect after 1000 rounds. Two others, weighing four tons, looked pretty well after 1600 and 1700 rounds.

The fleet weighed anchor, and departed from Sveaborg, on the 13th of August.

In this connection I cannot omit citing extracts from a letter addressed to the *Times*, by Vice Admiral Napier, soon after the news reached England that Sveaborg had been bombarded.

—"After the capture of Bomarsund, Svea-

* See note at end of volume.

" borg was again examined, and it was the opi-
" ion of the French Marshal, the Admirals and
" myself, that we had not the proper means to at-
" tack so formidable a fortress (we had neither
" gun nor mortar-boats) and that the season of
" the year was too much advanced."—

—" General Jones was of opinion that by
" landing 5000 men on the island of Bakholmen,
" throwing up works, and then making a simul-
" taneous attack with the fleet it might be re-
" duced in seven or eight days. This plan was
" unanimously rejected. General Niel was of
" opinion that it might be knocked down in a
" couple of hours by 7 or 8 sail of the line;
" but he added that it would be an operation
" *très hardi*,—that such had never been at-
" tempted, and it was not his province to
" recommend it."

" These opinions were sent home, the people
" of England were not satisfied," &c. &c. &c.—

—" On the 26th of September, I went off
" Sveaborg in the *Lightning*, and stopped abreast
" of Grohara Island, about two miles south of
" Gustafsvard," &c.—" From this position, the
" fortress appears like batteries perched one on
" the other, pointing towards the sea."

" We could not get a view of the western
" defences, and I think General Niel, having
" only seen the western part of the fortifications
" for a short time, and at a greater distance, was
" rather hasty in giving an opinion that 8 or

"10 sail of the line would lay it in ruins in "two hours."

—"I wrote to the Admiralty to say, if Svea- "borg was attacked by a *fleet alone*, they would "approach from southward in one line, raked "by 160 guns. One or two of the leading "ships would anchor and occupy the batteries "at Bakholmen,—the next would pass on, fire "a broadside into the three-decker, and anchor, "clear of her broadside, against the S. W. angle "of Gustafsvard; she would be followed by the "next, pouring a broadside into the three-decker, "and anchoring ahead of her leader, and so on "in succession, as close as the ships could lie. "By this time, the three-decker would probably "be sunk, and the whole western face of Svea- "borg engaged."—

—"A small squadron would be required to "anchor south of Langorn. They would have "to contend against it and two or three line-of- "battle-ships and what guns were in Helsing- "fors."—

—"Whether this attack would succeed or not, "it is impossible to say."—

—"Since my report an attack has become "easier." The Admiral goes on to say he advo- cates the use of gun-boats with Lancaster guns and 13-inch mortars, which should produce con- flagration, and "much evident impression on the "fortress; the ships should then close up and "finish the work."—

—"How long this would take, I could not "say, but I was quite certain the fortress would "be laid in ruins, and most probably an entrance "opened to the ships."—

—"Of iron floating batteries which could "hardly swim, and if they could, would have "been useless, for had they been placed within "400 yards of Sveaborg, they would have been "annihilated; and at 800 yards, they would have "done no harm."

The views here expressed are of great interest, being derived from an examination of the fortress and batteries by the commanders, who were probably to conduct any operation that might be resolved on, and therefore under a full sense of the responsibility of the undertaking. No one of them seemed to doubt that the place could be taken, though they differed essentially as to the manner of accomplishing it.

Vice Admiral Napier at first proposed (June, 1855,) to use gun-boats, each armed with a single very heavy gun, and 13-inch mortars, established on the rocky islets that abound about the harbor. In the letter, partly cited above, this operation was to be preliminary, and designed to ruin the defences, upon which the heavy ships would close in and conclude the affair.

Yet one may well be sceptical as to the power of vertical fire and distant cannonade from sea, even with the heaviest ordnance, to materially injure fortifications so carefully constructed as those of Sveaborg; when it is remembered that the works at Sevastopol, after sustaining an unprecedented concentration of fire from innumerable pieces of the largest calibre, displayed terrible energy even to the last. The artillery of the Redan never sent forth more murderous volleys than on the day which saw it pass into the possession of the Allies; and it is now known that the evacuation of the south side had been determined on by General Gortschakoff previously to the final assault, not because the works were too much injured for defence, but on account of the great loss in men by the besieger's fire, the Russians having lost 900 to 1000 men daily for 30 days.*

Sveaborg might, no doubt, have been submitted to a fire quite as severe, from hundreds of mortars and heavy cannon; but the men in the works could have been sheltered until the approach of the large ships made it necessary to man the batteries, which had not been possible at Sevastopol, because an instant would have sufficed to precipitate a whole army across the narrow space that separated the lines of attack and defence. Unless then the works

* General order by Russian Commander-in-chief.

at Sveaborg had been in a great measure crippled, and most of the guns rendered unserviceable, the ships must have suffered terribly while coming down in single file to engage the batteries in the passes; and should a single ship have been disabled in the narrow channel, so as to obstruct the free way of the others following in close order amid the dense smoke, the confusion that might ensue, almost under the very muzzles of the Russian guns, would have been very disastrous,—perhaps irreparable so far as the prosecution of the attack was concerned.

General Jones preferred to rely on the ships after an attack on the principal work by a regular siege battery.

But General Niel must have entertained a higher idea than usual with engineers, of the capacity of ships' batteries, or a very low estimate of the Russian defences, to suppose that eight or ten sail-of-the-line could knock down the fortress in a couple of hours.

The Russians themselves, who had not hesitated to sink a fleet in order to improve the defence of a point, which, however important, was less so than Sveaborg, seemed to be entirely at ease in regard to any attempt to enter, as they left the channel perfectly unobstructed, when the sinking of a single ship would have sealed each narrow pass.

The Vice Admiral expresses great contempt for the floating batteries; but their first trial,

which occurred soon afterwards at Kinburn, seems to warrant a more favorable estimate of their power; they might not be able to perform all that a sanguine advocacy promised, but they proved to be not altogether harmless at 800 yards, and might not have been annihilated at 400 yards; though their endurance of 32-pdr. and 18-pdr. shot at half a mile, is no evidence of the effect that 68-pdrs. and 10-inch shot would exert upon them at 400 yards, particularly if any portion of the fire enfiladed the vessels. They certainly promised to compel quite as much attention from the Russians, as the distant vertical or horizontal fire, and therefore might assist materially in relieving the ships from a portion of the fire to which they were exposed.

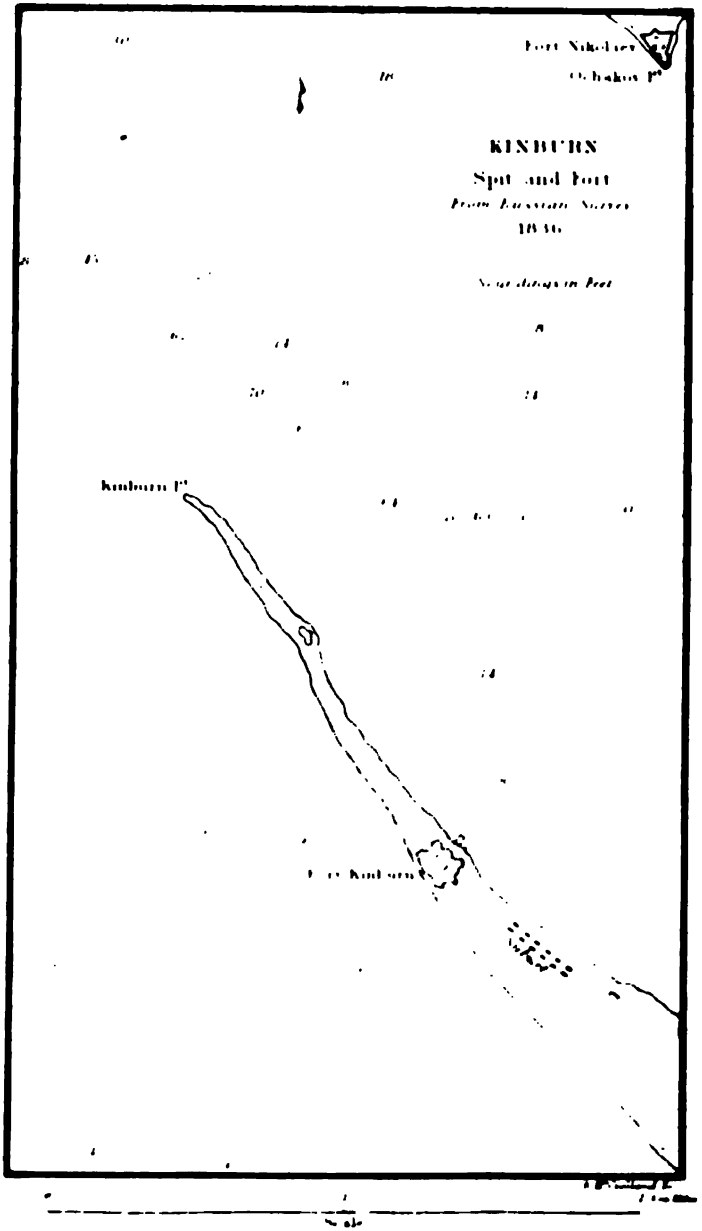
KINBURN.

(From official accounts by English and French Admirals.)

The fleet, with some thousand troops of both nations on board, left Kamiesch on the 7th of October, for the purpose of reducing the forts that guard the entrance of the Estuary, into which flow the Boug and the Dnieper.

The object of the expedition acquired its chief importance from the fact, that on the Boug, at no great distance from its mouth, was located Nicolaieff, the great depot of Russian naval stores and of construction, where the southern fleets of the empire are built: and on the Dnieper, not far from its embouchure, is Kherson, a place of considerable trade.

Morever the loss of Nicolaieff and Kershon might seriously menace the communications of the Russian army in the Crimea, and compel its retreat from the peninsula without the necessity of assailing in front the position it held on the north side of Sevastopol, said to be even more formidable than the works on the south side, which this same army had just relinquished after a year's siege; during which, every inch of ground had been contested with fearful loss to both sides, and finally terminated in an orderly retreat of 70,000 men across the harbor, equally admirable for the ability of de-


KINBURN
Spit and Port
1846
Kinburn Pt

sign and undaunted steadiness of the troops under most appalling circumstances.

The Boug and the Dneiper issue into a large basin, formed partly by the projection of the main shore, partly by a long, narrow strip of sand beach which continues from it and takes a northwesterly direction, until it passes the promontory of Otchakov, where it terminates, and from which it is separated by the channel whereby the waters of the Estuary empty into the Black Sea.

The distance between the spit, or extremity of this tongue, and the Point of Otchakov, on the main shore opposite, is about two miles; but the water is too shoal to admit of the passage of large vessels of war, except in the narrow channel that runs nearest to the spit and its northern shore. Here, therefore, are placed the works designed to command the entrance. They are three in number. Near the extreme point of the spit is a covered battery, built of logs, which are filled in and overlaid with sand,—pierced for 18 guns but mounting only ten.

Advancing further along the beach is a circular redoubt, connected with the spit battery by a covered way. This work, built of stone and revetted with turf, is open, and said to be the most substantial of the three; it has 11 cannon, and within is a furnace for heating shot.

Further on, and where the beach has widened considerably, is Fort Kinburn, a square bas-

tioned work, extending to the sea on the south, and to the waters of the Estuary on the north. It is casemated in part, though but few of these embrasures were armed,—its chief force being in the pieces *en barbette*, and some 9 or 10 mortars. The masonry, though solid, is represented by an eye witness not to be bomb proof, and so dilapidated by age that the mortar was falling out from the interstices, leaving the stone to disintegrate. The interior space was occupied by ranges of wooden buildings, slightly constructed and plastered over.

This fort is said to be armed with 60 pieces. The English Admiral states that all three of the works mounted 81 guns and mortars. The calibres are not given officially, but stated in private letters to be 18-pdr. and 32-pdr.

The Allied force was admirably adapted to the operation, embracing every description of vessel from the largest to the smallest, and all propelled by steam. There were screw-liners, and like vessels of inferior class—side-wheel steamers, screw gun-boats, floating batteries, mortar-vessels, &c., each armed in what was considered the most approved manner.

The expedition was detained at Odessa by adverse winds until the 14th of October, when it left under steam and anchored off Kinburn that evening, the *Royal Albert* just out of range of the main work. To prevent all accident from the shifting character of the sandy bottom,

measures were taken without delay to verify the soundings, and mark the channel into the basin of the Dnieper. About midnight, four English gun-boats, (*Fancy*, *Boxer*, *Cracker*, *Clinker*,) and four French gun-boats (*Tirâilleur*, *Stridente*, *Meurtrière* and *Mutine*) dashed in under full steam: the Russian guns opened, but too late, and the last boat alone was struck without material injury. Next morning they were seen from the fleet, anchored N. E. of Fort Kinburn, and thus the communications across the basin were cut off.

15th of October. Early in the morning bodies of English and French troops disembarked, landing on the beach some three miles east of the fort, and traced lines against any relief from that quarter. In the afternoon, the mortar-vessels supported by some steamers, took position along shore some 2500 yards from the eastern face of the fort, and made good practice, but without any notable effect on the men at the barbette guns, who replied to the fire. Their shot and shells, however, were entirely unequal to the extreme range, and fell in the water very wide of the mark. A swell coming in rendered the fire from the mortars uncertain, and they ceased.

Soon after the mortar-vessels began, the village near the fort was perceived to be in flames, supposed to have been communicated by the Russians, in order to remove all obstructions to

the play of their guns. The French soldiers, however, extinguished the fire before it extended far.

The 16th was unfavorable to any operations from the fleet, for the wind blew on shore, and produced a considerable swell. The troops occupied themselves in further precautions to secure their position; and no firing occurred from the fleet, though the guns of the fort were occasionally opened on the gun-boats that had entered the basin.

The plan of attack originally contemplated by the Admirals is thus given by the correspondent of the *Times*.

"No. 1. The line-of-battle ships to engage the Fort Kinburn and two sand batteries on the point, will anchor in about 30 feet, in a line extending northward from fort, bearing E., and about 1200 yards distant from it.

"No. 2. The four French line-of-battle ships to form the southern division, so that the *Montebello* will be the fourth ship from the south, and the *Royal Albert*, as the fifth ship, will be the southern ship of the English division.

"No. 3. The line-of-battle ships are to weigh together and form a line abreast, north and south, at a cable apart. The southern line-of-battle ship is then to steer so as to bring the south end of Kinburn Fort bearing E. by compass, and, to shield her from any danger that may not have been discovered, or from approaching too close to the bank to the S., she is to be preceded by two steamers, the ——— and the ———, each at a cable apart, and in advance, on her starboard bow, and showing their soundings. When the south line-of-battle ship brings the south end of Kinburn to bear E., she is to steer for it. The rest of the ships will then steer the same course, keeping one cable apart, and all anchor together in a line nearly north and south, just without the flag buoys that will be placed during the previous night.

"No. 4. The nine ships will then be in position for the first five or six to engage Fort Kinburn at from 1200 to 1400 yards, and perhaps less, and the other three to take the sand batteries in flank and rear, at about 1000 yards.

"No. 5. The three French floating batteries are to be placed on a line N. N. W. and S. S. E. of each other, to the S. W. of Fort Kinburn, at about 600 yards distant from it.

"No. 6. The mortar-vessels are to anchor in a line E. and W., at 2800 yards distant, with the fort bearing N. E. from the outer vessel of the line.

"No. 7. The English mortar-boats to be towed by the *Odin*, on a line E. of the French.

"No. 8. If the outer mortar-vessel brings Ocznkoff telegraph on with the east end of Fort Kinburn, bearing N. 20 E. (magnetic,) and steers for it till the Ocznkoff telegraph and Odzak Point subtend an angle of 70 degrees, she will be about the requisite distance of 2800 yards from Fort Kinburn; the rest can take their stations at a cable distance east of her.

"No. 9. The *Sidon*, *Curaçoa*, *Tribune*, *Dauntless* and *Terrible*, to anchor close off the North Sand Battery on Kinburn spit, or when ordered, to join the squadron of gun-boats, &c., that have previously entered within the straits, should any large ships of the enemy from Nicholaieff appear for the relief of Kinburn.

"No. 10. The disposable paddle-steamers can find good positions between the line-of-battle ships for directing their fire with steady aim at the embrasures of the casemates or at any position where the enemy maintains his fire, or off the N. and N. W. extremity of the Kinburn spit, to enfilade the batteries and their approaches.

"No. 11. The gun-boats will attend to protect the army during the landing, and those not ordered to remain to cover their flank, to take up position between the other ships as opportunity offers, and by a careful attention to the plan of attack are not to fire in the direction of the other ships.

"No. 12. The Admiral holds the captains responsible for their

being no firing, unless the men can distinctly see the objects they are directed to fire upon.

"*Triton* and *Beagle* to attend *St. Jean d' Acre*. Each ship's boats to land her own troops. Reserve ammunition for the marines to be landed with them. *Spiteful* and *Furious*, assisted by *Triton*, to land 21 cavalry horses, 7 staff horses, 27 regimental staff horses from No. 197, and 60 sappers, with tools, &c.

"The captain of each ship is to be responsible for the disembarcation of his own troops and baggage."

It is stated that this plan was materially altered on the passage from Odessa to Kinburn, but in what particulars is not given,—though it would seem that the line-of-battle ships were not able to approach as near as was contemplated for the want of sufficient depth of water.

During the night of the 16th, the wind shifted off shore, so that next morning the water was perfectly smooth, and the Allies lost no time in using the auspicious moment.

The French floating batteries (*Devastation*, *Lave*, and *Tonnante*,) steamed in to make their first essay, anchoring some 600 or 700 yards off the S. E. bastion of Fort Kinburn, and at 9.20 opened fire, supported by the mortar-vessels, of which 6 were English,—by the gun-boats, 5 French and 6 English,—and by the steamer *Odin*, 16.

The heavy metal of the floating Batteries (said to be 12 50-pdrs. on the broadside of each) soon told on the walls of the fort, and the vertical fire was so good that the French Admiral attributed to it, in great part, the speedy sur-

render of the place. The gun-boats also made good ricochet practice, which was noticed to be severe on the barbette batteries.

The Russian gunners, in nowise daunted by this varied fire, plied their guns rapidly in return, directing their attention chiefly to the floating batteries which were nearest.

Exactly at noon, the Admirals steamed in with the *Royal Albert* 121, *Algiers* 91, *Agamemnon* 90, and *Princess Royal* 90, with the four French liners, in close order, taking position in a line ranging N. W. and S. E., about one mile from the fort, in 28 feet water.

At the same time a squadron of steam frigates,* under Rear Admirals Stewart and Pellion, dashed in through the passage to the basin, opening fire on the spit and central batteries in passing, and anchoring well inside of Fort Nicholaiev and Otchakov. The attack seaward was completed by the *Acre*, 100—*Curaçoa*, 30—*Tribune*, 30—and *Sphynx*, 6—opening on the central Battery,—while the *Hannibal*, 91—*Dauntless*, 24—and *Terrible*, 21, assailed that on the spit. To this storm of shot and shells, the Russians could not reply long. In the spit battery, the sand falling through between the logs displaced by the shot and shells, choked the embrasures, and

* *Valorous*, 16 — *Furious*, 16—*Salon*, 22—*Leopard*, 12 - *Glatton*, 4 - *Firebrand*, 6—*Stromboli*, 6—*Spiteful*, 6—*Arrogante*, *Cacique*, and *Sané*.

blocked up the guns. In the fort, the light wooden buildings were in flames at an early hour,—then the walls began to crumble before the balls which came from every quarter, front, flank, and rear; and as the guns were disabled successively, the return became feeble, until few were in a condition to be fired, the central redoubt alone discharging single guns at long intervals. The Russian Commander, however, made no sign of surrender; but the Admirals, seeing that his fire had ceased and further defence was unavailing, hoisted the white flag at $1^{h.}$ $35^{min.}$ P. M., upon which the works were given up on honorable terms.

The garrison consisted of about 1400 men; their loss is differently stated,—the French Admiral says 80 wounded,—another, 43 killed and 114 wounded.

The English suffered the least, having but two men wounded, besides two killed and two wounded in the *Arrow* by the bursting of her two 68-pdr. Lancaster guns.

The superiority of the Allied vessels in number and calibre of ordnance was very decided; they must have had at least 650 pieces in play, chiefly 32-pdrs. and 8-inch shell-guns, with a fair proportion of 68-pdrs. and mortars, besides the 50-pdrs. of the French floating batteries. To which the Russians could only reply with 81 cannon and mortars, and no guns of heavier calibre than 32-pdrs., while many were lower. The great

disparity in offensive power was not compensated to the works by the advantage of commanding position,—the Russian fort and redoubt being upon nearly the same level with the ship's batteries, and also very deficient in proper strength. On the other hand, the depth of water did not allow the Liners to approach nearer than one mile, and thus their fire was by no means so intense as it would have been at shorter range.

This was the sole occasion in which the floating batteries had an opportunity of proving their endurance; which was the question of most importance, as no one could doubt the effect of long 50-pdrs. or 68-pdrs., when brought within a few hundred yards of masonry, and able to retain the steadiness indispensable to a breaching fire.

No siege operation had ever embraced batteries of such power, for though the English had employed long 68-pdrs. at Sevastopol, yet the distance from the objects exceeded a thousand yards, and the concentration of fire, so far as any opinion can be formed from the published statements, was far inferior to that of the 36 50-pdrs. in the broadsides of the three batteries anchored in close order.

They were hulled repeatedly by shot,—one of them, (the *Devastation*,) it is said, 67 times, without any other effect on the stout iron plates than to dint them, at the most one and a half inches,

—still there were 10 men killed and wounded in this battery by shot and shell which entered the ports,—and the majority of damage to the French personal, (27 men,) occurred in the three floating batteries.

The presence of the gun-vessels and gun-boats formed another novel feature to the operation. They originated in the necessity of having light but well armed steamers to operate in the shallow waters of the Baltic and Black Sea.

The largest employed at Kinburn were the gun-vessels *Arrow*, *Lynx*, *Beagle*, *Viper*, *Snake* and *Wrangler*,—all of the same class,—dimensions 165 by 26 feet,—470 tons, and 160 horse power,—armed with two 68-pdrs. of 95 cwt. and two or four 12-pdr. howitzers,—their speed considerable and draft light.

The gun-boats present, such as the *Fancy*, *Clinker*, *Grinder*, *Cracker*, *Boxer*, &c., were of inferior dimensions, draft and armament.

The passage of these boats under steam by the guns of the water batteries on the spit, from which they could not have been further than 900 or a thousand yards for a part of the time, is of great interest, though the operation was assisted by the obscurity of night: only one gun-boat was struck by shot. The next day, however, the *Cracker* went out in broad daylight, escaping unhurt the entire fire directed at her,—which is very suggestive of the facili-

ties that steam may be expected to afford in evading the fire of batteries.

Considering the importance of excluding an enemy from the basin of the Dnieper, some surprise may reasonably be excited at the feebleness of the defences which were to command the entrance.

They were inferior in every respect, and manifestly incapable of withstanding any serious operation by sea or land. The main fort was particularly weak in design, and dilapidated—all of them were indifferently armed and garrisoned.

A division, constituting no great part of the Allied fleet, proved to be able in a few hours to silence every gun and render the works wholly untenable.

It is out of the question to suppose that the Russians undervalued the importance of preventing access to the basin, where the ships of an enemy could disembark and support a force moving upon Nicholaiev and Kherson; or that they over-estimated the strength of the works on the Spit. The explanation must be found in some other motive, as yet not made known.

Remarks.

The foregoing summary comprises some notice of the most important operations during the late European war, in which naval forces participated; and though the three great maritime Powers were principals in the contest, and employed more formidable fleets than had ever yet been drawn together, no instance occurred where battle was joined between their ships. On one occasion, (Sinope,) an attack was made by a division of Russian ships-of-the-line, upon a division of Turkish frigates; but the overwhelming force of the former was such as not to permit one to discriminate throughout the action between the effect of the many shot and of the comparatively small number of shells, though the latter was plainly manifest at the commencement, before the view became obscured by the smoke of the cannonade and of the burning ships. Nor was any aid derived from the use of steamers by either party during the action, though one or two small vessels of that description were present on both sides.

We are, therefore, still without any positive realization of the effects which the *new motor* and *new weapon* may produce in combination with other elements, upon the general conduct and result of sea-engagements; and the problem

in which professional men are anxiously interested, still awaits a practical solution.

Yet there is much to be gleaned from the incidents of this war, which, in the absence of more complete evidence, will contribute measurably to confirm or qualify the current opinions derived from the isolated facts of scanty experiment, and from the speculations to which they may have led.

So far, nothing has occurred in the course of the war, calculated to abate the reasonable expectation of advantage from the use of steam as a motor for ships of war. The results under fire have, on the whole, been quite favorable, and the resistance of large vessels has proved adequate to the protection of the Screw-Engine, and its appliances, against continued firing of no ordinary character; as in the case of the *Agamemnon* and consort, which steamed in to 800 yards from the formidable batteries of Fort Constantine, anchored and lay there for five hours, suffering severely in hull, masts, spars and men, but yet able to steam out of action at the close of the day.*

* It is said that a bomb "passed through all the decks of the "*Charlemagne*, and burst among the machinery, partially disabling it." Grivel, 31 ; but, from its designation, this projectile appears to have been thrown from a mortar, and its vertical descent through the decks confirms the inference.

Ships are much less liable to be struck by the vertical fire of bombs, than by the horizontal practice of shot or shells from

Even the side-wheel steamers are not found to be as vulnerable to the fire of artillery as was justly apprehended from the unavoidable exposure of many essential portions of the apparatus. We see, for instance, that the Russian vessels, which were of this description, plied about the harbor of Sevastopol almost with impunity throughout the whole siege of eleven months, harassing the batteries continually, at long range, and, when required by the exigency, moving within fair scope, where they operated with destructive effect alike on the massive columns or the scattered marksmen. We believe, that though hulled repeatedly, their locomotive powers were never observed to be crippled in the course of this service, even to the very night amid the gloom of which they were consigned to destruction by those who had so well used them.

These results are, however, so far qualified by circumstances, as to be unavoidably partial in their character. In the case of the *Agamemnon*, when the distance might have been

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cannon; but when struck, may suffer more seriously from the former, as the strength of the decks is by no means equal to that of the sides, and the innermost parts of the vessel are, therefore, less difficult of attainment to the vertical descent of bombs. We have already seen, that at Sveaborg, a three-decker, (the *Russia*,) was nearly destroyed by a single bomb, which, passing through the decks, as in the case of the *Charlemagne*, exploded in dangerous proximity to the magazine, and would have been fatal to the ship but for the most timely exertion.

made decisive if the heaviest calibres had been employed, there is reason to believe they were only of the usual description—while the Russian steamers were ordinarily at the extreme range of their own very heavy ordnance, and that which was brought to bear on them.

The power of the artillery was, therefore, plainly reduced much below what will be exhibited in conflicts at sea, when such vessels are engaged with each other.

Its accuracy was also seriously impaired by the continual movement of the steamers, to which Captain Boutakoff attributes his evasion of the storm of shot and shells that chased the *Vladimir*, when in dangerous proximity to the shore batteries. But this advantage must be reckoned as proper to the steamer under all circumstances, so long as the functions of the motor are not crippled; and its application was obvious in the earliest naval operations of the war, as may be seen by the mode of attack at Odessa, where the Allied steamers were kept moving in a circular track, at a convenient point of which they delivered their fire.

This peculiarity in steam tactics is, therefore, to be provided against, by some corresponding practice with the guns; and it may be, that well-aimed volleys will be found more effective than firing by single rounds, the chances of striking being multiplied in proportion to the number of pieces in the battery.

Another prime advantage, obtained by the use of steam in ships-of-war, is the ability to attain the position desired without regard to the direction of the wind, or of the course, when forts or batteries are to be attacked. On such occasions, the ship is exposed to the deliberate and full fire of the work while approaching it, without the power of making any effective return at the time, and this while threading channel-ways where dangerous obstructions may exist that are no longer marked by buoys or beacons; to ground on which might terminate the enterprise, or cause the loss of the vessel.

Steam removes much of this difficulty,—the conduct of the action is relieved of the troublesome conditions imposed by the use of sails, —and a deal of complicated manœuvre thus avoided; while the attention of the commander, no longer divided and distracted by such considerations, may be given wholly to the operations of his battery and those of his antagonist. The services of the sail-trimmers may also be appropriated to the guns. If a number of vessels are to be brought into action, the station of each vessel, great or small, and the time for reaching it, are determinable with as much exactness as the movements of regiments or brigades; so that ships-of-war are now endowed with a precision of evolution, and a power of concentration before unknown, the

lack of which has hitherto seriously detracted from their proper value, and frequently been productive of disaster.

The effects of shells upon ships were not by any means exemplified to the extent that might have been supposed, in the action just cited; for it so happened for some cause or another, that they were seldom employed against the Allied squadrons. At Sevastopol only, were vessels of large class subjected to a steady fire of this description, and the general effect varied in no important respect from that which has already been assumed (pages 216, 232,) as probable. The shells were distributed over the surface of the ships, penetrating or lodging with every variety of effect; and being generally of inferior calibre, they seldom, if ever, entered parts where their explosion would have endangered the flotation of the vessel, or the engine.

At Sinope their operation was strikingly manifested, particularly as regards incendiary properties, which proved to be most formidable. One frigate was fired and blown up in five minutes from the shells of the *Constantine's* lower deck guns, and another shared a like fate by the shells from the *Paris*. The other ships were afterwards successively enveloped in flames, and the surviving Turkish officers, when questioned

on the subject at the instance of General Paixhans, concurred in attributing the conflagration to the shells.

On subsequent occasions, the same consequences were observed to attend the use of shells and bombs. At Odessa, the French Admiral states, that "the shells of the seven "frigates fell like hail on the battery of the Im- "perial Port and the store-houses and vessels it "contained, when symptoms of fire began to "manifest themselves."

At Bomarsund, flames were speedily produced in the South Tower by the bombs which the Russians threw into it as soon as they perceived that the French were in possession. At Sevastopol, the ships were frequently on fire, and, though difficult under the circumstances to determine when this might have been due to the hot shot, yet the incendiary action of the shell could at times be distinguished. At Sveaborg, the flames that broke out rapidly and in different places, and finally combined in one wide-spread conflagration, were created entirely by the bombs and shells of the ships—the rockets not being used until night, when the fire was well established. At Kinburn, the buildings within the works were also promptly fired by the bombs and shells.

The practice of the Allied ships exhibits a marked improvement in precision and scope of fire, thereby promoting the concentration of the numerous guns in large vessels, and giving a value to the broadside not generally appreciated. In no previous engagements has the effect of ship's batteries been developed, beyond point blank, so powerfully and with so much certainty; a result to be credited mainly to the elevating sights, and next, to an efficient percussion system which, enables the marksman to follow his aim instantaneously with the blow.

But in noting the advance thus made upon the slovenly practice common to the ships of these powers in former years, it is well to know that further progress is possible and most desirable in developing the power of the broadside. A few facts just at hand will make this evident.

The distance of the *Agamemnon* and *Sinspareil* from Fort Constantine (17th October, 1854) was assumed to be about 800 yards; Lord Raglan states it to have been rather less. These two ships could bring to bear about 87 guns, and the firing from them probably lasted some four hours. There can be no doubt that it inflicted much damage, for the Russian Commander-in-Chief admits it in his official report—but not sufficient to impair the strength of the masonry, and far short of effecting a breach in it.

At Bomarsund, the results were rather different:—Three 32-pdrs. of 42^{cwt} (guns of inferior

weight) were landed from a ship's spar-deck, and placed in battery at 950 yards from the North Tower—the masonry of good quality and 6½ feet thick. In eight hours the wall between two embrasures was cut through, from top to bottom, offering a practicable breach, to effect which, 487 shot and 45 shells were fired*,—being at the rate of one round from the battery in rather less than a minute, or, from each gun, one in 2¾ minutes. The Tower surrendered.

It seems almost incredible that three pieces should be able to accomplish fully that which eighty-seven pieces utterly failed to do, the distances from the object being alike,—particularly when it is considered that many of the latter were of greater calibre, and most of them employed much heavier charges where the calibres were similar. The guns of the ships, if fired at the same rate as those of the battery, which was not unusually rapid, (one round in 2¾ minutes,) would have discharged some 7700 shot and shells in the course of the four hours, supposing no interruption: a number which, if properly applied, would appear from the results of the three guns, to have been sufficient to breach the wall of the fort in fourteen places; whereas they did not effect a single breach, which is abundant proof of the lack of accuracy. They must either have been dispersed over the surface of the fort,

* Report of General Niel, Commanding Engineers.

or else missed it altogether, and this could have been due only to a want of the precision which was attained by the battery. The constantly preferred complaint of motion in the ships was not to be urged, because on the day of cannonading Sevastopol, there was scarcely a breath of wind, and the ships were too large to be easily moved by the swell, unless very considerable. That the fort did no greater damage to the ships, than it received from them, proves no more than that its fire was quite as illy directed, and the calibres too low. It is said that the *Agamemnon* was struck in the hull by 240 shot and shells, which must have been but a small portion of what were fired, though sufficient to be decisive if, as already observed, the calibre had been heavier.

As there was only an occasional breath of air to move the dense clouds of accumulating smoke, it is to be supposed that the impatience of the men to fire, rendered good aim impracticable, and only increased the obstruction. But if the inability to see the object were a good reason for not hitting, it was a better reason for not firing at it. Of course, it really matters little whether bad gunnery arises from *indifferent means*, or an *indifferent use of good means*, —the consequences are the same.* We are

* Are we at liberty to infer, that considerations of this nature had some influence in suggesting the injunction contained in the 12th Section of the General Order, directing the plan of attack on Kinburn, just one year later? (Page 285.) "The Admiral "holds the Captains responsible for there being no firing, unless

not, however, prepared to admit that the fire from guns in a ship, if perfectly steady, should be so far inferior to those in a land battery, as not to be able to approximate the effect of the latter with twice or thrice the number of shot; and, whatever advance may have been made in ship firing, supposing previous practice to be taken as a criterion, it is very certain that a great deal remains to be done, if reference be had to what was effected by these three guns.

But there is a limit to the scope of the best artillery, which cannot be exceeded with any good effect, even if the means of aiming were sufficient, and circumstances permitted their full use in disposing the bore of the piece with perfect precision and exactness.

The following may be cited to exemplify this remark:—

At 260 yards, ten shot from a long 32-pdr. were included in four feet square of the screen fired at.

Ten shot were fired from the same gun at a screen distant 1300 yards,—40 feet long by 20 feet high,—and only three of the shot struck the screen.* So that when the distance was increased five times, a like number of shot from the same gun were so much dispersed, that fifty times the surface would include only

"the men can distinctly see the objects they are directed to fire "upon."

* Experiments from Naval Battery at Washington, 1850.

one-third of the number discharged,—and thus a fire which would have been decisive at 260 yards, so far as accuracy was concerned, would have been utterly useless at 1300 yards.

There is a limit also to the effective fire even of the heaviest pivot-guns, which is dependent on the circumstances under which it may occur. It will be perceived, for instance, that at 25 cables'* length, a stationary object as large as the hull of a first-class steamer, was only struck by ten shot out of 500 (two per cent.) fired in the most deliberate manner, (once in six minutes,) from a battery of 68-pdrs., manned by expert artillerists, which had also the advantage of being some 600 feet above the plane. At three-fourths the distance, (18 cables' length,) the accuracy was improved; but still only six shot out of 60 hit the *Vladimir*, (ten per cent.) Had the latter, or the battery, been in motion, the probability of striking would have amounted to the fraction of a chance, and would hardly have justified the expenditure of more ammunition than would have indicated such a probability.

* We are not informed exactly what is the value of this expression in the Russian service. Even with ourselves it is somewhat changed. In the time of hempen cables it meant 120 fathoms, 240 yards.) But chain cables, which have become almost universal, are not restricted to the 120 fathoms. Those made for the United States Navy vary from 120 to 180 fathoms. Thus the term may ere long become purely nominal. It may be noticed that the English Charts frequently divide the sea mile into lengths which are designated as cables' lengths—making the measure equivalent to 203 yards, (101½ fathoms.)

It was also obvious that the force of the 68-pdr. shot was so far spent, that no lesser calibres could have made any serious impression at so great a distance,—for it appears that the 68-pdr. shot were just able to get through the side sometimes,—while at others they were arrested by the metallic fastenings; and it was only when they perforated about the water-line, that they proved troublesome.

On the other hand, the shells from the battery were rendered inefficient probably in part from a lack of calibre, but chiefly from an apparent desire to make too close practice; both elevation and fuzes seem to have been nicely adjusted to a distance just a little less than what it actually was, and had the *Vladimir* been some two or three hundred yards nearer, she might have suffered seriously. As it was, the shells either fell into the water, short of the mark, and then burst, or, if they ranged better, they burst in the air too soon.

The explosion of the English shells in the water, as well as in the air, shows good fuzes,* and the sensation experienced in the vessel by the concussion, indicates that considerable effect would have resulted had the shell been lodged in the vessel; far more than that produced by the perforation of the shot.

Captain Boutakoff thinks he was more lucky

* In that particular practice at least.

with his shells, and expresses a decided preference for them under the circumstances. His practice conformed to this opinion, as it shows that he fired two shells to one shot, though the former were necessarily from the least efficient gun, (the 10-inch shell-gun;) and he avers that sometimes three shells would strike the embrasures in succession,—which is indeed more surprising, at the distance, than that others which followed should go wide of the mark.

It may be observed by the way, that the opinion expressed in regard to the value of a good side, (pages 202, 203,) finds some confirmation in the different effect of like projectiles on the two vessels. The *Gabriel* was a line-of-battle-ship, and would therefore, be expected to possess the advantage of the stoutest possible material and construction,—which, however, was not the case,—for the *Vladimir* was built in England, and much more strongly. The difference was so considerable in the resistance of the two hulls, to whatever it be due, that the shot which barely perforated the *Vladimir*, went through and through the *Gabriel;* and might have damaged her steam apparatus irreparably had the ship been so fitted.

We ought not to pass unnoticed the extraordinary and most powerful use which Captain Boutakoff made of grape. Showers of canister or grape from mortars are commonly resorted to in the attack and defence of land works, but the

distances are limited, and the practice comes under the form of vertical fire. Direct practice with grape from shell-guns, at one or two miles, is a novelty, and its efficiency in this case is so well authenticated, that one only wonders why it was not thought of before. The Russian and French commanders both speak of its powerful action on troops not likely to be checked by ordinary obstacles. (See page 418.)

As the operations of the Allied fleets were entirely restricted to blockade, and the attack of Russian fortified harbors, the results contribute more directly to determine how far the previous relation between ships and forts have been modified by the introduction of steam and shells, than to exhibit the influence which these agents are likely to exercise on the conduct or fortunes of strictly naval engagements. We are thus led to approach this much vexed question which otherwise might have been passed by.

In general the main advantage of the ship is in the power of bringing to bear upon any given part of the fort, a larger number of powerful cannon—far greater than a single work can direct upon the ship. The material of the latter is easily penetrated by the shot, or shattered and ignited by shells: while the solid masonry is incombustible, can only be shaken and breached

by a continued repetition of shot striking within a limited section, and is proof against shells until disunited and laid open by shot. But the men and guns of an uncovered battery, not much elevated, are open to the storm of shell, shrapnel or grape, which the ship can direct upon them from her more numerous pieces. On the whole, however, the introduction of heavy shells is more advantageous to the fort than to the ship.

But the new motor is entirely adverse to the fort. With sails alone, the privilege of the initiative belonging to the ship was much circumscribed, and the power of retreat very uncertain—but with steam, the choice of attack is almost independent of circumstances, so long as there is sufficient water to float in.

The approach of the ship can be effected so promptly as to abridge materially the time of being subjected to the fire of the fort without the power of a return. The crew need no longer be exposed aloft to grape or musketry, but can be sheltered on deck by the bulwarks. The bustle and confusion inseparable from coming to under sail is avoided, and perfect silence reigns along the decks—the force at the guns is not enfeebled by the absence of men who are to shorten sail, and undivided attention may be given to the battery, the distance, and the direction of the object. The desired position can also be taken with exactness,—a few signals from the bell arrests the ship there, and a brief order

indeed fully adequate to compensate for any defect in its character or extent, number or calibre of guns. For the accuracy of the ship's fire is much impaired by the necessity of pointing at an object considerably elevated, as well as by the drifting smoke which renders very nice direction almost impracticable: while the fort, comparatively free from this embarrassment, and able at all times to aim by the masts and yards that tower far above the indistinctive hull, plays down upon it with impunity. Illustrations of this will be remembered in the cases, so frequently cited in previous wars, where batteries rather insignificant in character, have overmatched powerful ships;—and occasionally also in those of recent occurrence.

Thus the small works on the heights of Cape Constantine, inflicted more severe injury than the redoubtable fort lower down at the margin of the water; damaging five ships in the most serious manner, and compelling them to haul out of action in order to avert consequences that might have been fatal; while the fort was unable to drive off the two ships that stubbornly held their stations until dark.

But it may be observed that even this great advantage will not justify the reduction of the work to the least scale, such as that of the tower or redoubt with one, two, or three guns, so frequently cited to demonstrate the inferiority of the ship. For if this be absolutely the nature of

tion of site gives, can never be extended so far as to render works on this small scale capable of resisting the force which a ship can employ; —and there is hardly an instance where they have not been reduced by the ship when attacked as they should be.

The fire of a small barbette or uncovered work, can always be kept under by the rifled musket and shrapnel, judiciously posted, taking the advantage of such shelter as the locality affords, or using pits for the sharpshooters if necessary. The broadside can then be brought to bear, or the men sent ashore in force to assault—circumstances may even admit of the landing one or two cannon to breach the work.

The unqualified assumption, that a tower or small redoubt, with its two or three guns, can of itself make good the defence against a heavy ship, would naturally suggest more than is contemplated; for in that case, why resort to the cost of extensive works to defend a harbor, when a few towers might fully answer the purpose? But the fact is, that the advantage of site which is required to give effect to this species of defence, is rarely to be found just where it is needed. It existed neither at Cronstadt nor at Sveaborg; and at Sevastopol the elevated works of this nature only served to command the position for attack on Fort Constantine from seaward. Of themselves they could not have prevented the entrance of a

The attempt to pioneer a close attack with ships upon fortresses of this description, by distant bombardment and cannonade, is not likely to assist the operation materially as may be seen in the affair at Sveaborg, where it is known that the strength of the defences was untouched by the storm of bombs, shells and rockets which were hailed upon the place without intermission for two days.

Works which are less complete in all respects, cannot, however, be assumed as impregnable; and just as they happen to be insufficient in plan, execution, armament or garrison, so are

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of shore works is so rare, that it should be regarded as really an exception to the general rule of their service, which is the attack of wooden structures like themselves, then it seems to follow that naval ordnance should correspond in its character to these purposes, and be adapted to shells rather than to shot; with the endurance, however, competent to discharge the latter if an exigency should arise. And these views have governed in the armament of the United States screw frigates (*Merrimac* and class) recently built; the new ordnance of which has been well proven to be able to fire a greater amount of solid shot than have ever been appropriated to guns intended for that service only.

The first XI-inch shell-gun, for instance, was fired 500 times with shells, and then 655 times with shot weighing 170lbs., without being burst,—which eventually only occurred at the 1959th round. The whole practice was carefully conducted under the eye and direction of the intelligent and able officer, then acting as executive of this department, Lieut. Ap. Catesby Jones, U. S. N.

It is not, therefore, because these guns are unable to withstand the discharge of shot, that none have been supplied to the frigates armed with them, but because the occasions on which shot could be advantageously used, are so rare as hardly to warrant their being considered as part of the regular allowance.

they liable to be assailed by ships with a corresponding prospect of effect.

Advantage of site and position will, however, compensate for most of these defects, and enable the work to use its artillery with the greatest possible power, while that of the ship will be nearly nullified.

The use that can be made of floating batteries as auxiliaries in attacking shore works, must depend on further confirmation of their asserted invulnerability. It may be that the performance at Kinburn answered the expectations of the French Emperor as regards offensive power; for that is a mere question of the battering capacity of the heaviest calibres, which is undoubted:—but the main issue, which concerns their endurance, cannot be settled by the impact of 32-pdr. shot fired at 600 and 700 yards. Far heavier projectiles will in future be found on all seaboard fortifications; and the ingenuity of the artillerist may also be exerted more successfully than at Kinburn. Still it is not to be doubted that the floating battery is a formidable element in assailing forts, even if its endurance falls short of absolute invulnerability, and the defence will do well to provide against its possible employment.*

But the question between the ship and fort assumes another phase when the object lies beyond the latter, and the passage only is com-

* See Note at end of volume.

manded by its artillery. This is expressed by high official authority, as follow:—

"In most cases, however, forts are not liable "to a siege or to any attack that will keep an "enemy more than a few hours before them; "they are required by sudden action to defend "the passage of a river or a channel leading to "important objects," &c., &c. (Report of Gen. Totten, Chief of Corps of U. S. Engineers.)

The problem is *then* restricted to the time that the ship may be under fire, and the probable injury that can be inflicted in that period by the cannon of the work: and here the steam power intervenes to increase the chances of success, by conferring greater certainty and celerity of movement.

By its aid, passages may be accessible that have proved too intricate to be attempted by sailing vessels. The period of exposure to fire can always be estimated very nearly, and the celerity of movement augmented by making use of a fair wind and tide; or advantage may be taken of dark and stormy nights, thus reducing the chance of being struck to a mere accident. Even in broad day, the opportunity of the marksman is much lessened by the celerity with which the object moves right across the direction of fire, and the difficulty is not a little enhanced by the absence of the voluminous canvass. The shot and shells that, in a direct conflict, might, by their continued

operation, surely dismantle the ship, and perhaps eventually work out her destruction, must now act on vital parts only if they are to be effective. They must breach the water-line, or overcome the greatest endurance that the hull is capable of, and penetrate into the very vitals of the ship, disabling the engine or reaching the magazine. In this way alone will the assailant be arrested in his onward course; and the rarest good fortune will be needed to reach such a result.

The operations at Kinburn furnish some incidents to the point:—There it became important to extend the attack along the north side, and thus to complete the circle of fire about the works; but the channel was not very direct, and, by reason of the shifting bottom, uncertain; it was moreover reached at the narrowest and most winding part by the guns of the three works, at ranges of not less than 900 yards. Yet eight gun-boats passed in under steam, and escaped the fire of the batteries unharmed. They had, it is true, the friendly obscurity of the night—but the next day one of them (*Cracker*) returned in broad daylight, and, though exposed to the deliberate fire of the works, passed unhurt again. The well-proved and excellent qualities of the Russian gunners, leave no room to call their skill in question on this occasion.

It is true that these vessels offered no great mark; but then all they did offer was vital—no

shot or shell that reached the slight hull, even in its strongest part, could have failed to penetrate it; and in so doing would most probably inflict fatal injury to the engine. A frigate or Liner would have offered a more ample object, but little more of surface as important—and that far better defended by the greater resistance. Above, the towering sides might be shattered, men killed, and guns dismounted, without arresting her progress or impairing the offensive power to any material extent.

Hence it is manifest, that the capacity of works to arrest a passing ship, or squadron, is very much lessened by the introduction of steam; if indeed it can now be relied on at all.

Some such view must have been impressed upon the Russian councils, when it was determined to close the port of Sevastopol.

Probably no harbor was better adapted, by nature and art, for resisting offensive operations purely naval, the approach being commanded by batteries of unusual power; while within, the harbor for 3000 yards from its mouth, was covered at every spot by the converging fire of works that either swept the surface with shot, or plunged them from above. And yet, upon the first news that the troops at the Alma had failed to arrest the invasion, and thereby laid open the road to the place, a part of the fleet was promptly sunk across the entrance so as to form a barrier to all access in force.

For although no object, commensurate with the risk, was to be attained by passing the forts, so long as the attack was confined to ships, yet the issue assumed a totally different aspect when connected with an assault by land. The upper part of the harbor was remote from the heavy batteries below, and not guarded by works of any magnitude. Here, too, the Russians well knew, lay the key of the whole southern side, city and suburbs. The formidable lines that soon grew up across hills and ravines, were as yet untraced, and the tower of the Malakoff alone marked the position which, when subsequently appreciated by the attack, was so eagerly coveted and so dearly won. The whole site for the defence in this quarter was swept in reverse at grape range from the harbor, and liable to be enfiladed on either hand from the Careening Bay by a still closer fire.

The sunken barrier evidently anticipated the hopes of the French General, who instantly comprehended the full force of the measure.

In the official language of the Admiral, "he "could not help regarding it as deplorable, be- "cause it concurred to modify in more points "than one, his plans of attack."

Had the entrance been left unobstructed, a division of ships might have chosen its opportunity to enter, in defiance of the scathing fire of the batteries, which could only have been continued while the assailants were on their rapid

way. In a brief space the Russian ships would have been laid close aboard, and the batteries must then have ceased, or in the melee have dealt equal damage to friend and foe. The result could not but be fatal to the Russian fleet, and in that catastrophe must have been involved the destruction of the resources of artillery and gunners which, for nearly a year, fed the ever-memorable defence of Sevastopol.

Looking to results, it was almost immaterial whether any of the attacking ships should escape capture. There was no need longer to continue a weary blockade; for the entire Russian Navy here was annihilated, to be renewed no more during the war,—while the right of entrance, subject to the condition of a passing fire, was secured to the fleet, speedily renewed by fresh ships,—and with it the ability to harass the defence,—to emperil the communication across the harbor so as to effectually cut off material supplies to the south shore and thus reduce the defence there from the imposing scale of an intrenched front for a whole army, to that of a work with a limited garrison, that could not be reinforced to any extent with men or means, nor drawn off when these were exhausted.

Nor would an efficient co-operation have been impracticable with an assault on the suburb—the broadsides sweeping in reverse at close range the defences about the Careening Bay, thus taking the very part which the Russians played

so decisively on the 18th June, when the French storming columns attempted to carry the works to the east of the Malakoff.*

The blocking of the harbor, then, was a masterly move.—It gave at once entire unity to the defence,—closed all access to the interior communications,—permitted the conversion of ship's batteries and crews to service at the front†—and enabled the battalions of an entire army to throw up the extended lines which rifle and bayonet and cannon so well defended afterwards. Finally, when the havoc and ruin of the besieger's artillery had rendered untenable every spot on the south side, and their troops had wrested the key of the whole position, it made possible that superb feat of consummate generalship, the withdrawal of an entire army across a

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* The French General, Pelissier, says:—"This crushing fire "came not only from the works which we wished to carry, but "also from the enemy's steamers, which came up at full steam "and manœuvred with great skill and effect. This prodigious fire "stopped the effort of our troops, &c."—

The Russian General, Gortschakoff, says:—"Our batteries on "the north side and our steamers which swept the enemy's "columns at every point upon which they could bring their guns "to bear, contributed considerably to the success of this brilliant "affair: the steamer *Vladimir*, in particular, commanded by "Captain Boutakoff, approached repeatedly the entrance of Ca-"reening Bay, from which point it swept the enemy's reserves."

† "Les ressources qu'il tire de ses vaisseaux immobilises dans "le port, tant comme personnel, que comme materiel, sont presque "inépuisables," &c.

(*General Canrobert's Official Dispatch, 22d October.*)

wide bay—not as terror-stricken fugitives, but in perfect order—to the northern shore, where the troops were displayed in full array and ready for battle—in sight of an enemy who, no less brave, could well appreciate the proud and imposing spectacle.

These views we think lead to the conclusions, that

—The defence of a sea-board can only be made complete by the employment of Forts and of Ships;

—And that it is indispensable in all cases when a Naval attack upon works can be conducted in full force, to be prepared to receive it with every advantage in plan and execution that the art of the Engineer can furnish;—a task certainly not difficult in a country like our own, where the most ample means abound, and an excellent Corps of Engineers are ready to apply them.

NOTES.

NOTES.

RIFLED CANNON.

Page 128.—"*Other efforts have been made which, though not "so well known, promise to afford better results.*"

Among these may be mentioned the experiments in France upon the shell-gun of 22cm, bored to a 30-pdr.

This is rifled with two grooves, 0m.275 wide—0m.039 deep, and a length of 19¼ feet to the revolution of the spiral.

The projectile weighs 54½ lbs., and has a cylindro-conic form. On its surface, at the poles of a given diameter, are two rounded protuberances or nipples (tetons) with an elliptical base.

These are to enter the two grooves in the bore, which they may be said to touch at but a single point, and thus the desired rotatory movement is imparted to the projectile.

The principal dimensions of the projectile are as follows:—

	m.	
Whole length.....	12.838	
Length of the cylindric part (nearly).....	4.883	
Diameter.....	6.419	
Projection of the nipples, a, a.....	0.394	
Diameter of the circular base of the nipples,	3.307	horizontal.
	2.835	vertical.
Diameter of the fuze hole.....	0.866	
Length of the canal.....	0.433	
The charging hole is at 60° from the fuze hole —its diameter is.....	0.433	.512
Windage.....	0.079	

The fuzes are of wrought iron and secured by a screw thread.

The projectiles are cast vertically, the point downwards, and with a head upon their base, in order that the point where the fuze is to enter, shall be perfectly solid and free from cavities.

It is understood that an order has been issued to the foundry at Ruelle to make 40 of these pieces, and that 30 of them have been cast.

Their completion, and the casting of ten thousand projectiles are to be urged with the utmost activity.

It is said that ranges exceeding 5400 yards have been obtained with this Ordnance, the elevation being 15° and the charge 7¾ lbs.

Tables of practice have also been formed from the experiments at Gavre.

In Belgium, experiments were instituted at Brasschaet to test the merits of the French Rifled Cannon, and the results are believed to have been satisfactory.

CONCUSSION FUZE.

Page 151.—"*But all the devices that have yet come under my "notice in the official examination of various inventions, were com- "plicated to a most objectionable degree, and proved exceedingly "uncertain in their operation.*"

An officer of the Belgian Artillery, Captain Splingard, already well known as the inventor of an ingenious Shrapnel Fuze, has, however, been more fortunate in contriving a Concussion Fuze which offers every expectation of successfully meeting the difficulties that have hitherto proved insurmountable to experimenters in this matter. So that Military and Naval men will have ample means of comparing the effects of Concussion shells with those acting by time fuzes.

An account of this fuze is found in the excellent work of Col. Delobel (Technologie Militaire,) for a copy of which I am indebted to my friend Colonel Bormann of the Belgian artillery. The description of it is thus introduced:—

"In July, 1850, Captain Splingard suggested an explosive fuze, "simple of construction, easy of preparation, quite inexpensive "and differing but slightly from the ordinary fuze in the facility "and generality of its application. It is moreover entirely dis- "tinct from all other explosive fuzes yet invented, in the total

"absence of fulminating powder, and every species of percussive "mechanism."

"It may be conceived that, if possible, the Belgian artillery "would have preserved for its exclusive use the secret of this "valuable invention; but it has been purloined from it, no doubt "through the dishonesty of some inferior agent."

"It being known certainly that specimens of the Splingard "Fuze were in the possession of several foreign powers, particu- "larly those of England and Holland; and moreover that one of "those bad citizens found every where, who would sell soul and "country for a little gold, had also acquired the secret, and was "just at this time endeavoring to sell it abroad, the superior "authority thought proper to allow Captain Splingard to publish "his invention; it is in virtue of this authorization, and in order "to disappoint the calculations of speculators, and counterfeiters, "that we have requested leave of that officer to annex a descrip- "tion of his fuze to the statement about to be given of experi- "ments lately made in Prussia on the important question of "percussion projectiles, for in this species of missiles, as in "Shrapnel, the difficulty lies entirely in the fuzes," &c., &c.

The limits of a Note hardly permit more than an abstract of the description that follows in detail.

In the Splingard Concussion Fuze, the composition is driven into a paper case, which itself is to be received in a wooden tube set firmly in the fuze-hole. It is lighted as usual by the charge of the gun, and, unless its action be accelerated by the peculiar arrangement, will burn for a certain time and then act,—like any other fuze.

The means to determine the explosion by concussion, are simple and most ingenious. The composition is driven on a spindle, as frequently practised in driving rockets; this leaves a conical cavity extending from the bottom well up into the mass of the hardened composition, precisely like that of a rocket. The interior surface of the cavity is then protected by a coat or two of shell-lac; and when this is perfectly dry, it is filled with a paste of plaster of Paris and water, which, before becoming hard, is also pierced with another spindle, smaller than that used to drive the composition, and producing a cavity in the plaster also. So that when dry, it forms an interior crust upon the composition.

Now, at the time of firing, this casing of plaster being fully supported, remains unbroken,—but when the composition has been lighted it consumes rapidly, and reaches the plaster cylin-

der, around which the combustion continues, and thus exposes it gradually. So that more or less of the upper portion is laid bare when the shock of impact takes place, and is fractured by it, opening a communication from the flame to the charge of the shell.

There are several neat little contrivances by which the fuse is rendered better able to fulfil its function.

The first trials were made in 1850, from an 8-inch mortar, and resulted so well, that a more formal experiment was ordered.

This took place at Brasschaet in 1851, resulting as follows:—

Mortar of 29 c., (11½ inches); elevation, 60°; target, 600 paces.

224 bombs were fired. 204 exploded at the first graze; 13 exploded when the fuze had burned its whole length, the concussion apparatus not acting. Two exploded prematurely. Two not at all,—and the fuses of three bombs did not catch fire.

Col. Delobel considers these the most perfect results ever obtained with a concussion fuze, and conclusive as to the success of the invention, so far as mortars and light howitzers are concerned. Some trials from a 24-pdr. howitzer followed. 31 shells were fired, of which 10 burst at the first graze, 17 at the second, and 4 in the gun. The failures to act as intended, were accounted for so far to the satisfaction of the commission, that the fuze was deemed to be as suitable for practice from cannon with high velocities, as from mortars; which opinion was amply confirmed afterwards by trials executed annually with every variety of ordnance.

In 1853, experiments were made upon a wooden target, which were also satisfactory.

We hope to have a future opportunity to explain this excellent device in detail, and perhaps to offer some results of practice with it, on this side of the Atlantic.

Composition of Batteries.

Page 279.—"*In some of the ships the shell-guns in broadside "were so numerous, as to be constituted into an entire tier,*" *&c., &c.*

The preference for shell-guns so clearly manifested by the British authorities, in the changes here noted in the armament of their ships, appears to be sustained by the results of their experience, if we may judge from the style of armament said to be adopted for one of their finest ships recently built, and just put into service, the *Shannon*.

As much interest must necessarily attach to this vessel, we note, in the absence of official data, the following details from the public journals:—

Length between perpendiculars,.....	235 feet.
Beam,.....	50 "
Burden,.....	2661 tons.
Armament,..main deck, 30 8-inch of 65 cwt.	
" ..spar-deck, 20 32-pdrs. of 58 cwt.,—1 68-pdr. of 95 cwt.	
Horse Power, (nominal,).....	600
Cylinder, diam.,.....	70 in's.
Stroke, length,.....	42 "
Screw, diam.,.....	18 feet.
Crew,.....	550

The *Shannon* is strictly a frigate; that is, she carries her battery in two tiers, one being uncovered, but in tonnage is equal to a large two-decker,—with much more length, equal beam, and less draft.

The main force of armament is an entire tier of shell-guns, (8-in. of 65 cwt.), on the gun-deck. On the spar-deck are 20 32-pdrs. of 58 cwt., and a long 68-pdr. (of 95 cwt.) on the forecastle.

The remarks that have been made in relation to the comparative force of the United States' ship *Merrimac*, and the British ships *Shannon* and *Eurydice*, induce me to offer a few words on the subject.

The batteries of these ships may be stated thus, from the best sources that are accessible to us.

	Gun-deck.	Spar-deck.
Euryalus,	28 of 8-in. (of 65.)	22 32-pdrs. of 45.$^{cwt.}$
Shannon,	30 of 8-in. of 65$^{cwt.}$.	20 32-pdrs. of 56$^{cwt.}$, and 1 68-pdr. of 95$^{cwt.}$
Merrimac,	24 of IX-in.	14 8-in. of 63$^{cwt.}$, and 2 X-in. of 107$^{cwt.}$

Taking the mean weight of iron that goes out of the guns to any one point, the ships will discharge, *Euryalus*, 1066 lbs.; *Shannon*, 1167 lbs.; *Merrimac*, 1424 lbs.; so that even by this standard, the *Merrimac* would have the superiority in offensive capacity by a ratio of 100 to 82.

But such a mode of estimating the power of ordnance is only admissible when the description of gun is the same in both ships, or, if different, when the distances are so short that the hastiest shot will neither miss the mark nor fail to perforate. When, as now, it is expected to use the advantages of heavy calibres for superior accuracy and force beyond mere point blank, the amount of metal that issues from the broadside, does not supply the criterion of power, *but that which strikes the object and with due force.*

Relative accuracy and penetration are, therefore, to be considered in estimating the value of ships' batteries like those now spoken of.

There is no difficulty in deciding between the *Shannon* and the *Euryalus*, because both have similar calibres, 8-inch on the gun-deck, and 32-pdrs. above.

But the *Shannon* has more of the 8-inch shell-guns, and heavier 32-pdrs. than the *Euryalus*, and hence has unquestionably the more powerful armament, whether far or near, in a ratio somewhat greater than the absolute weight of broadside. Besides which, she has a 68-pdr. on the forecastle.

Now, as regards the *Shannon* and *Merrimac*, the 772 lbs. of 8-inch shells from the gun-deck of the former are inferior not only in mere weight to the 864 lbs. of IX-inch from the gun-deck of the latter, but also in accuracy and power, so that a distant object will be struck by less of that weight and with less force. The accuracy of the 8-inch to IX-inch being about as 5 to 7, the penetration as 9 to 10, and the content of powder as 5 to 6, with the further advantage to the IX-inch of greater effect by reason of the superior content of the individual shells—larger orifice and greater shock of impact.

Then on the spar-deck, we have for the *Merrimac* 360 lbs. of 8-inch shells to oppose the 325 lbs. of shot from the *Shannon;* the accuracy of the 8-inch shells to the 32-pdr. shot being as 5 to 3—

the shock and orifice greater, with the addition of the explosive force of 14 lbs. of powder.

The *Merrimac* has also 2 pivot X-inch to meet the one 68-pdr.; that is, 200 lbs. in heavy shells to meet the one 68-pdr. shot or one 8-inch shell.

It is of course impossible, nor is it necessary, to deduce the *exact* value of the combined results, but we think that a glance at the facts will convince that the *Merrimac* not only has the advantage in absolute weight of projectile, *supposing all strike*, but that the greater accuracy and power beyond point blank will increase this difference very much in favor of the *Merrimac*.

The United States' ship has also the capacity to bear more battery than now carried. Her tonnage is one-fifth greater than that of the *Shannon*, and according to the ratio of armament to burden in the latter ship, (1 : 16¼,) the *Merrimac* should (other things being equal) bear with equal ease about 196 tons of ordnance, while in reality she only carries 153 tons, which is absolutely seven tons less than the weight of the *Shannon's* guns. The addition would give 10 more IX-inch guns, for which the *Merrimac* has at this time unoccupied ports on the gun-deck, and would raise the power of the *Merrimac's* broadside to 1780 lbs.—placing it, not only overpoweringly above that of the *Shannon*, but also on an equality with the broadside of the heaviest two-decked line-of-battle-ship in the British or any other navy. (See page 282.)

As for the speed of the *Shannon* or *Eurydus*, if superior, as claimed, to that of the *Merrimac*, the only advantage conferred by it, would be to choose the terms on which an action should take place; but the *Merrimac* having the greater ordnance power at any distance, the only privilege to be derived by the other ships from their superior speed, would be to avoid the action altogether, —which, as regards the *Shannon*, it is not to be supposed the commander would choose to do.

We are inclined, however, to question the greater speed of the *Shannon* under steam; because it is observed, that the comparison now referred to is based on 7 knots as the best rate of the *Merrimac*. Now, I happened to be in the ship when she went 8 knots, and have since seen a letter from an officer who states that in steaming from Brest to the Tagus, the rate of going was as high as 9½ knots.

to stand right over the line of the keel, and bear directly ahead—the draught is very light. There are about 160 of the gun-boats.

All these are driven by screws,—the steam-power corresponding to the class of vessel. The rate of the gun-boats is said to vary from 7 to 9 knots, and their draft from 4½ to 5½ feet. The larger classes have more speed, and are deeper in the water.

The rig is also alike in all,—being designed for a small spread of canvass, they have three short masts for fore-and-aft sails only,—no square sails.

In this flotilla are included two vessels, *Recruit* and *Weser*, of like denomination, but differing in many important particulars from the others, which indeed they preceded in point of time, having been originally constructed by private builders for the Prussian government.

These are of iron, 186 feet long, 29 feet beam, 550 tons burden, 7 feet draft at load-line.

They are driven by side-wheels, with an engine of 160 horse power.

The armament is heavy—four long 68-pdrs.—carried at the ends of the wheel-guards, one gun looking forward and another aft on each side; and in this way the line of fire may be made directly parallel with the length of the vessel.

The *Recruit* did good service in the shoal waters of the Sea of Azof, and is highly spoken of, being fast and an excellent sea-boat.

For the service contemplated, this fleet of small screw-vessels was well adapted—far better than any other—indeed, a very brief experience had demonstrated plainly the absolute necessity of some such means, in order to operate with any effect whatever in the Baltic and Black Sea.

English Mortars in the Baltic.

Page 387.—"*Next day, five more (mortars) showed defects of "like character, three burst, and the remaining three were seem-"ingly in no condition for much further service.*"

Extract from Mr. R. Mallet's "Physical Conditions," &c., &c.:—

"A number of 13-inch sea-mortars have been brought home dis-"abled from the Baltic, having failed on board the mortar-boats "during the bombardment of Sveaborg, after a greater or less "number of rounds, in a very remarkable way."—"Of the whole "number of mortars three have burst, or to speak more correctly, "*split*,—the remainder still appear to hold together, but the "strong probability is, that there is not a serviceable or trust-"worthy mortar remaining amongst them."

List of 13-inch Sea-mortars and names of Mortar-boats, with the number of rounds fired and Results.

Names of Mortar-boats.	No. of Rounds.	Cast at,	
Pickle,.....	414	Low Moor, ...	Split.
Growler,.....	355	Carron, ...	"
Mastiff,.....	148	Carron, ...	"

"Each of these three mortars was split with almost perfect ex-"actness into equal halves, by a plane passing through the axis, "and through the centre of the vent. There were no signs of "unsoundness in the metal at any point, nor any defect or sign of "injury, other than the splitting up, save that at the centre of the "bottom of each chamber, a small irregular cavity was formed, "with jagged sides and bottom, as though slowly burrowed into by "some corroding agent.

"The fractured surfaces, when rusty, presented a uniform, very "coarse grained character of metal; and when the latter was "freshly exposed by a large fragment recently cut out, close to "the interior at the muzzle of each split mortar, it proved to be "a mixed metal of the very coarsest grain, consisting of nearly

"white cast iron, filled with large grains of very dark gray and "highly graphitic iron, greatly wanting in homogeneity,—a mate- "rial ill suited to ordnance of any sort.

"The following mortars remained together, but in what condi- "tion I was unable to judge.

Names of Mortar-boats.	No. of Rounds.	Cast at.	Names of Mortar-boats	No. of Rounds.	Cast at.
"Havoc,.....	94	Carron.	Porpoise,.....	213	Carron.
"Rocket,.....	241	Low Moor.	Prompt,.....	184	Low Moor.
"Beacon,.....	176	Carron.	Drake,.....	129	"
"Surly,.....	131	"	Manly,.....	277	Carron.
"Grappler,....	311	"	Blazer,.....	287	"

—"I may mention, that an officer stationed in the Baltic "informed me, that these mortars were fired for some time as fast "as they could be loaded,—perhaps at the rate of 12 shells per "hour, or more. Possibly the success of the bombardment de- "manded great rapidity of fire; but the French mortar-boats, "having two mortars on board, which can be fired alternately, "possess an advantage over ours with but one."—"One of these "mortars was cast at Carron, perhaps more than 40 years ago."

FLOATING BATTERIES—13-INCH GUN.

Page 374.—"*Iron floating batteries which could hardly swim, "and if they could, would have been useless, for had they been placed "within 400 yards of Sweaborg, they would have been annihilated: "and at 800 yards, they would have done no harm.*"

Adm. Napier's Letter to the "Times."

The scepticism of Admiral Napier has not been borne out by subsequent experience, if we are rightly informed. It is said that a floating Battery was so fitted in England as to resist all the prac- tice made upon it, with the common broadside calibres, and the British authorities are now about to test it by firing shot of an extraordinary size

The published accounts of the gun to be used in the experiment, state that it is made of wrought iron, weighs 21 tons, 17^{cwt}, (48944 lbs.) is 14 feet long, has a diameter of 42 inches at the base ring, and a bore of 13 inches, which would require a shot of 280 lbs.*

We are told† that at Shoeburyness, 50 such shot have been fired from this gun with charges of 50 lbs. Selections from the practice are given thus:—

No. of the round.	Elevation.	Time of flight. Seconds.	First graze. Yards.	Extreme Range. Yards.
2.	Level	1.1	615	4835
5.	Level	1.2	648	5925
13.	1°	2.2	1008	4561
17.	1°	2.3	1115	4600
22.	3°	5.1	1890	3783
29.	3°	5.	1757	4161
32.	5°	7.7	2518	3510
37.	5°	7.2	2464	3575
44.	7°	9.2	3004	3488
50.	7°	9.2	2964	3396

The mean ranges of ten rounds are as follows:—

	1st Graze. Yards.
Level,	599
1.	1023½
3.	1800
5.	2433
7.	2988½

The deviation at 1st graze is said to have been "usually from 2 "to 4 yards; several times within a yard; twice at 12, once 16, "once 20, and once 26 yards, from the exact line, and 4 times "out of the 50 in exact line, without any deflection. At the "extreme range—the balls were usually found from 10 to 20 "or 30 and once over a hundred yards out of line."—

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* The *Illustrated News* says 336 lbs., which must be an error if the ball be spherical.

† *London Times* quoted by *New York Herald* of Dec. 14th, 1856.

We are somewhat at a loss to apply these data with exactness, not knowing the height of the gun above the plane, which is of importance as regards ranges to 1st graze, when the elevation is within 3° : but the power of such a projectile may well be imagined as enormous.

The material of which the British wrought iron gun is composed, must be good, in order to endure the strain even of 50 such fires.

Still the mass of metal is very considerable if estimated in terms of the projectile, the ratio being as 1 : 175, and much higher than that used in the new ordnance of the U. S. Screw Frigates.

Thus the English gun is three times heavier than the largest of our pieces (the *Niagara's* XI-inch); and, as the latter discharges shot and shells of 170 and 135 lbs. respectively, should throw a shot of 500 lbs. or a shell of 400 lbs.; while in reality its shot is 280 lbs. only, which is but twice as heavy as the XI-in. shell.

So the British 13-inch gun does not perform an amount of work proportional to its mass when compared with the U. S. XI-in. gun.

Now as regards endurance, the XI-in. gun, notwithstanding the economy of metal in its construction, has shown all that could be required, and very much more than usual. The first cast, was burst at the 1959th round with service charges,—as already stated in Note, page 411,—1304 being with shells of 135 lbs., and 655 with solid shot of 170 lbs.

So that notwithstanding the 13-inch wrought iron gun has *thrice* the weight of *material* to throw *twice* the weight of *ball*, it has a severe ordeal to pass through before it exhibits equal endurance with the XI-in. gun.

When the strength of the gun has been sufficiently established, however, it will then remain for those interested to determine on the practicability of using ordnance weighing fifty thousand pounds: and whatever may be deemed possible in adapting such to fortifications, some time will elapse before seamen will feel justified in taking the question into serious consideration. At present they are by no means agreed on the feasibility of using guns even of one third this weight

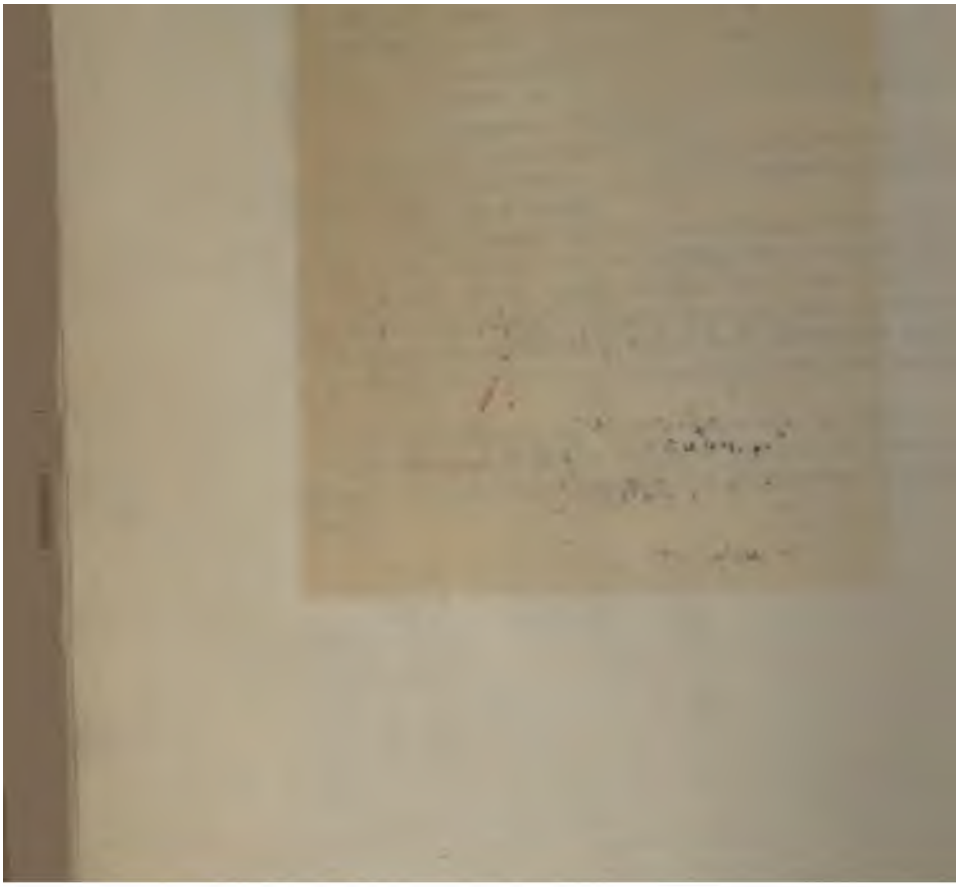
The proper material for the piece will also come into question then.

Of course no such mass of Iron (22 tons) has ever been cast into a piece of ordnance, and it is altogether conjectural, if it were, whether the endurance would go as far as that of the English 13-in. wrought iron gun has already gone. But if the Naval service should ever require such an operation to be undertaken, we can only say that we would not hesitate, if authorized, to set about it, and that in no despairing frame of mind. For our credulity has been so far taxed by the extraordinary progress of the times that we have long since come to the conclusion that it is not well to deny the test of trial to any project on the ground of its seemingly apparent impracticability.

The result might prove, that in such enormous masses, wrought iron alone would withstand the strain of projecting balls of 280 lbs., with 50 lbs. of powder.

But it is beyond doubt that cast iron cannon may be had sufficiently strong to project balls of 170 lbs., and in a mass only one third that of the English wrought iron 13-inch gun. It may also be, that wrought iron can accomplish quite as much; but it is certainly superfluous to require *more*, and equal strength in less weight would not serve, for the inertia would then be too low.

It was contemplated to enter at length on the subject of "Endurance," and a section had been written out; but the demands of other duty compelled the postponement for the present.



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